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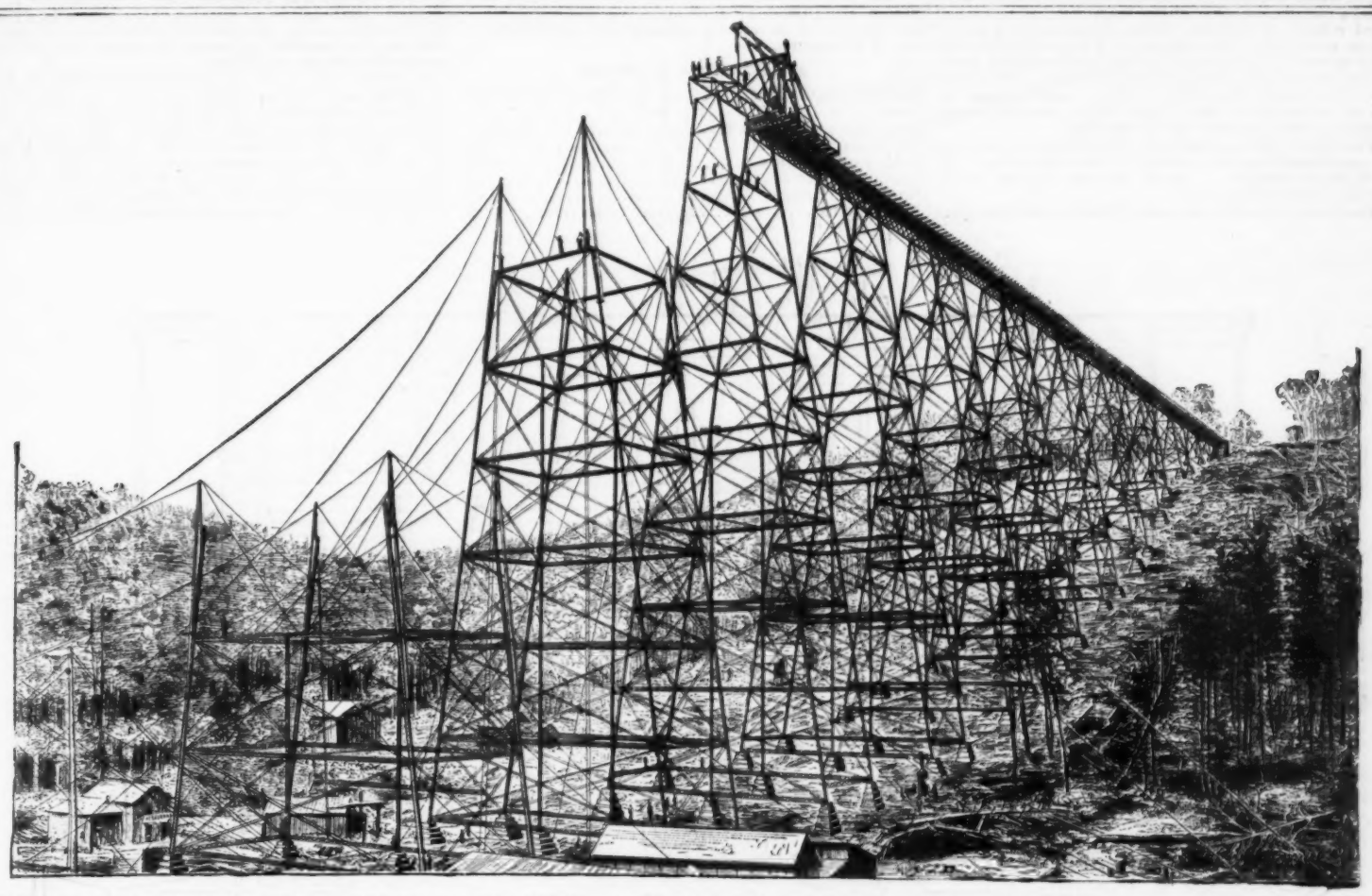
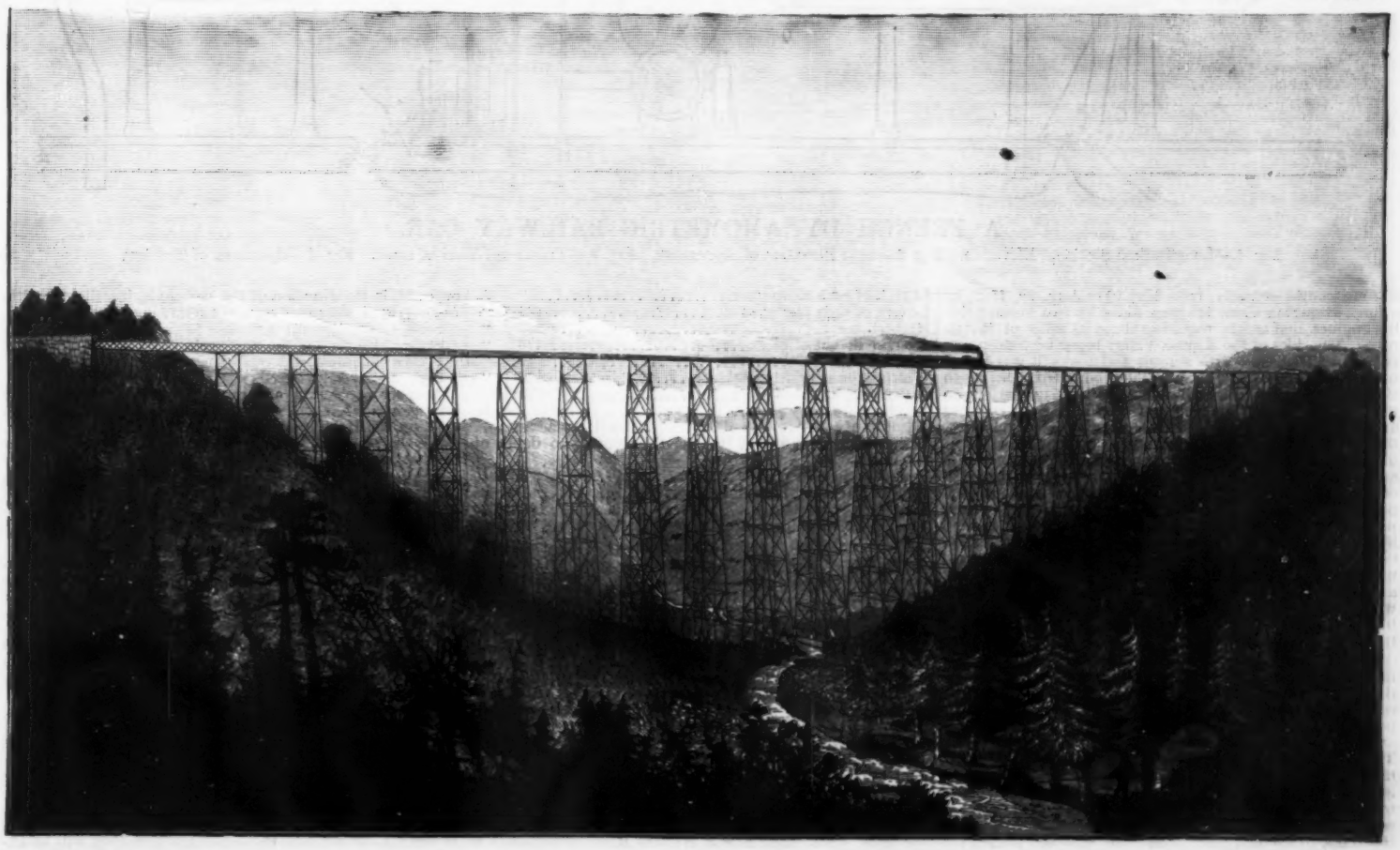


KINZUA VIADUCT.—NEW YORK, LAKE ERIE, AND WESTERN COAL AND RAILROAD CO. (See next page.)



KINZUA VIADUCT.—THE HIGHEST RAILWAY BRIDGE IN THE WORLD.—CLARKE, REEVES & CO., BUILDERS.

THE KINZUA VIADUCT.

OUR engravings represent the location of this remarkable structure and the method of erection. The lower engraving is from a drawing by John Toomey, C.E.; the other, showing progress of construction, and the following particulars, are from the *Railroad Gazette*. (See first page.)

The columns composing the towers were built in 30-ft. sections at the works at Phœnixville, Pa., and transported in cars by rail directly to the site of the structure. When placed in position these sections were connected together by wrought-iron sleeve joints placed inside the columns and firmly bolted, thus dispensing with the flanges generally used to fasten column sections together, and giving to the column when finished the appearance of a continuous post of iron. The four columns composing each tower, as above described, are thoroughly braced by horizontal lattice struts and diagonal rods fastened to the columns by bolts extending through them at the sleeve joints.

The whole structure is designed and constructed to withstand a maximum tension at the base of the highest windward column of 12,000 lb., which is resisted by a pair of 1¼-in. round bolts, giving an area of 2·4 square inches, and their upward pull is resisted by their being anchored under 20 tons of masonry. The longitudinal strains are distributed by a system of continuous heavy wooden beams on the top extending the whole length of the structure, which beams also serve as guard rails to the track.

The viaduct, as now completed, will sustain a moving load of consolidated engines covering it from end to end; this is of ample strength to insure the safe passage of the heaviest trains at high speed.

The work of erection was accomplished in the short space of four months—namely, from May 10 to Aug. 29, 1882, by a force averaging about 125 men, aided by two steam-hoisting engines and tackle requiring about 30 miles of Manila rope. The sides of the Kinzua Valley being very steep and rugged, and covered with stumps and rocks, it was necessary to lay a temporary track on the ground from the north side of the ravine to a point about half-way up the hill on the south side, for the purpose of distributing the columns and braces for the towers. This having been accomplished, the work of erection began by putting up four masts 60 ft. high, having pulleys at their tops, set on each masonry base and securely guyed by ropes fastened to trees in the adjacent forest. By means of these, the first four columns composing the lower section of the higher piers were placed in position, firmly bolted at the bottom, and braced at the top by the horizontal members, thus rendering the lower section complete and stable. The 60 ft. masts were then shoved upward about 35 ft. along the four columns already erected, and securely clamped, and by their aid the second section was raised into position in the same manner as the first, and likewise securely braced. This operation was repeated until the top section was reached.

It is proper to state that the first and comparatively low towers at the north end of the structure were raised entirely from the bottom in the manner above described, and completed ready for the trusses, which were swung into position from the top by means of a traveling derrick or crane which had been specially devised for this purpose. The track having been completed to the north abutment, this crane was placed thereon, and the workmen having set in place the trusses composing the first span, it was bolted to the top of the column; the timber floor system was then put on and the rails laid across this span, thus completing the track to the first pier. The crane was then pushed forward on its truck along the track already laid, and the trusses of the next span swung by it into position in the same manner.

It was found that the top section of the higher towers could be more conveniently placed in position by the use of the crane; it arm was, therefore, extended, and the Phœnix columns composing the upper section were hoisted from the ground and placed in their proper position in pairs, having been previously connected by their proper bracing, so that all that remained to be done was to connect and brace these pairs by the final longitudinal bracing, thus completing the tower ready to receive the 38½-ft. span truss, which was then put in position, the track system extended over it, and the trusses of the succeeding 61-ft. span were drawn forward and placed in position in the same manner. This process was repeated from tower to tower throughout the remaining part of the structure.

It is an interesting fact that the workmen, as the work progressed, became so expert that they climbed the diagonal rods and walked on the horizontal struts with as much facility and safety at the greatest elevations as if they were close to the ground; no scaffolding was required for their use, and none of the men was seriously hurt during the erection of the viaduct.

RECAPITULATION OF DETAILS.

North abutment ....20 ft. wide and 20 ft. high.	
South " ....24 " " " 25 " "	
Total length of iron work.....	2,053 ft.
No. of masonry piers....	110
Cubic yards masonry.....	7,000
No. of iron piers	20
No. of iron columns	110
No. of spans.....	41
Length of each clear span.....	61 ft.
Length of each pier span	38½ "
Highest pier.....	297 "
Average height of piers.....	176 "
Width on top.....	10 "
Width at base, widest part.....	103 "
Batter of columns of piers	⅓ of height.
Batter of masonry piers.....	6 in. per ft.
Masonry of piers	4 ft. square on top.
Bases range, from 8 to 18 ft. square, according to depth of foundations.	
Pounds of iron in viaduct.....	3,500,000
Steel in track and fastenings.....	100,000
Total cost of viaduct.....	$237,000
Time occupied in construction and erection	94 days.

The location of the railroad and the project of the crossing of the Kinzua by a viaduct was made by Oliver W. Barnes, the Chief Engineer of the Company, aided by Charles Pugsley, his Assistant Engineer.

The iron work was designed by A. Bonzano and T. C. Clarke, of Clarke, Reeves & Co., of the Phœnixville Bridge Works, and was erected by them under the immediate supervision of R. A. Simmons, Superintendent of Erection, in a very skillful manner.

The engineering of the work, during its erection, was superintended by Mr. Charles Pugsley, Principal Assistant Engineer to Mr. O. Chanute, Chief Engineer of the Erie Railway, Mr. Oliver W. Barnes having resigned the Chief Engineership of the Company, to take the contract for the construction of the railroad work, July 1, 1881.

The present President of the New York, Lake Erie & Western Coal & Railroad Company is Gen. Thos. L. Kane, of McKean County, and Robert Harris, Vice President of the New York, Lake Erie & Western Railroad Company is Vice-President.

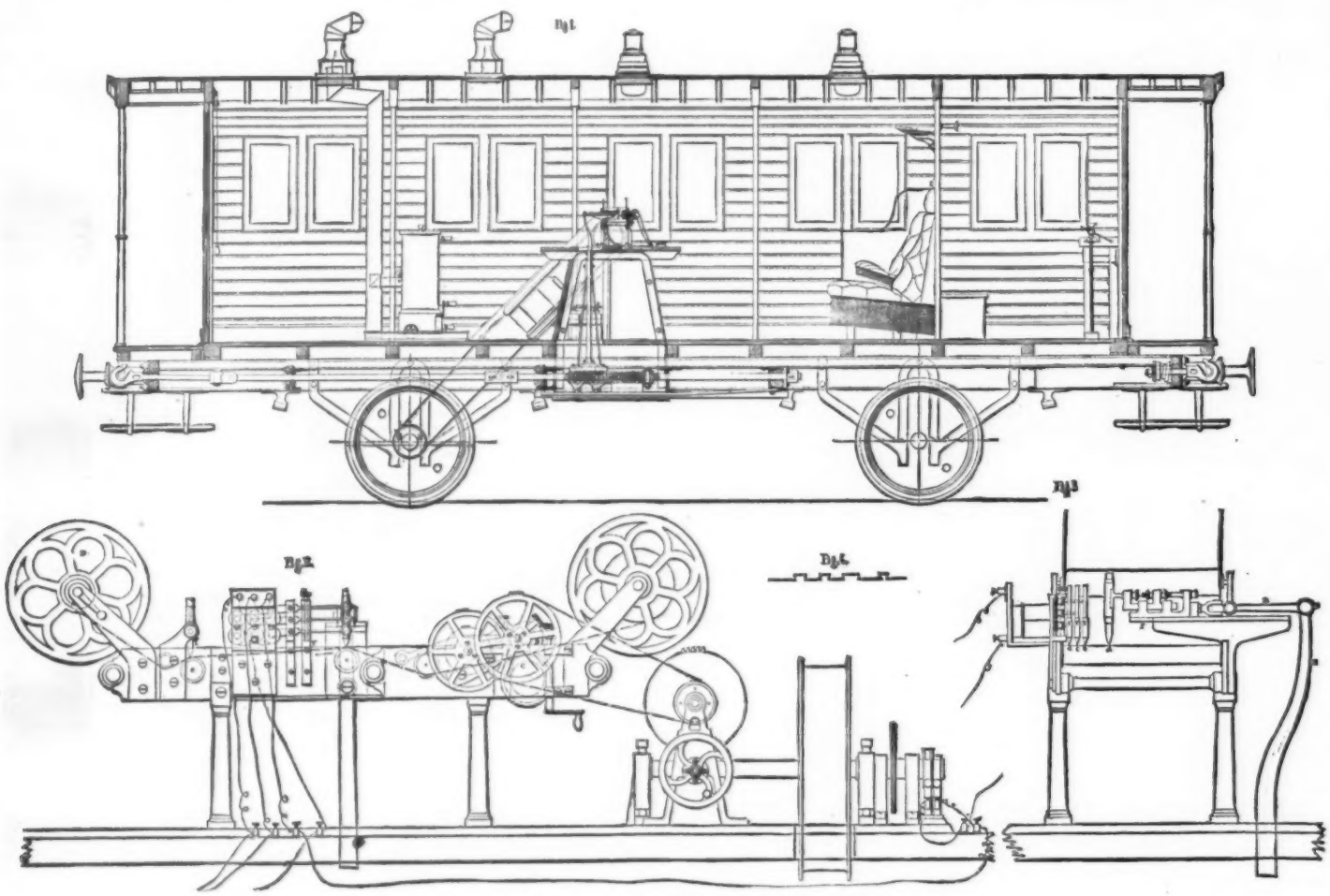
A FRENCH DYNAMOMETRIC CAR.

THE experimental car shown in the accompanying plate has been devised by the French Railway Company of the North with a view of determining whether the time allowed the enginemen to traverse a certain distance is properly in accord with the type of locomotive employed, the load of the train hauled, and the profile of the road; whether the loss of time resulting from starting, stoppage, or slowing up at forkings accords well in practice with what is supposed in theory, and, consequently, whether the delays that certain trains suffer are not due to the insufficient length of time allowed for making the trip.

The apparatus (Figs. 2 and 3), as a whole, consists of two drums, A and D, carrying the paper upon which the observations are to be inscribed; of two cylinders, B and C, which carry the paper along; and of the registering styles, *a*, *b*, *c*, and *d*, that inscribe the observations on the paper.

In order that the unrolling of the paper shall be proportional to the speed at which the train is running, that is to say, that there shall be no slipping of the paper, the cylinders, B and C, are so arranged that their degree of proximity may be modified by means of springs and binding screws acting upon one of them.

To obtain a very sharp tracing, uninfluenced by the jarring of the car, there is arranged upon the axle of the drum, A, a brake that permits of giving a proper degree of tension to the paper and of causing the tractive stress upon it to vary. Motion is communicated to the two cylinders, B and C, by a belt passing around the forward axle of the car, and they are stopped when necessary by means of a special gearing which throws the belt off the driving pulley. The registering apparatus, *a*, *b*, *c*, *d*, which are arranged upon the same



A FRENCH DYNAMOMETRIC RAILWAY CAR.

Fig. 1.—Longitudinal Sectional Elevation. Fig. 2.—Side Elevation of Apparatus. Fig. 3.—Transverse View of same. Fig. 4.—Specimen of Tracing.

ordinate, in the direction of the car's axis, inscribe simultaneously upon the paper band the following observations:

Style *a*. Tractive stress.
Style *b*. Position of the mile posts.
Style *c*. Time elapsed.
Style *d*. Space traversed.

Another registering apparatus traces a continuous line serving as a reference mark or as origin of the ordinates indicating the tractive stresses.

We shall now study the method of obtaining the different results sought.

1. *The Tractive Stress.*—The estimation of this is obtained by the aid of an elliptic dynamometric spring affixed to the drawhead of the car.

The movements of the spring are transmitted to the registering style, *a*, through the intermedium of a vertical rod, EE', and of a connecting rod, G, that actuates a small carriage, F, carrying the style, *a*. This carriage moves between two horizontal guides which are affixed to the frame, and which allow it to move only backward and forward.

The connecting rod is provided with a swivel joint, so that it may assume all the positions resulting from the oscillation of the point, E, without disturbing the rectilinear motion of the style carrier.

2. *Position of the Mile Posts.*—This is obtained very simply, as follows:

The registering style, *b*, is carried by a lever which is capable of revolving around a vertical axis. In the horizontal plane of this lever there is an electro-magnet in which the observer, by means of a commutator formed of a rubber bulb, can send a current and attract the lever carrying the style. It will be seen, then, that if when passing a post the observer sends a current into the apparatus, a tracing will be obtained like that shown in Fig. 4.

3. *The Time Elapsed.*—The style, *c*, is, like the preceding, affixed to the extremity of a lever capable of oscillating in a vertical plane, but is actuated by an electro-magnet controlled by an electric contact clock constructed by Napoli, and permitting of measuring one-fifth of a second. The electric contact occurs every ten seconds; and an interrupter placed in the circuit from the clock to the electro-magnet permits of actuating or stopping the style, *c*, at will.

4. *The Space Traversed.*—The number of revolutions of the wheels effected within a definite space of time is given by the style, *d*, which is affixed to the extremity of a lever moving in a horizontal plane. This lever is actuated by an electro-magnet controlled by a commutator, which is arranged in such a way as to give at will a contact at every revolution of the axle that drives the rollers which unroll the paper band.

At every contact the style, *d*, makes a line perpendicular to the direction in which the paper unwinds.

The three levers just mentioned are arranged, one under the other, upon the same vertical axis.

The styles consist of hollow glass tubes drawn out to a point at one extremity; and each fixed into a metallic holder which slides with slight friction in a vertical sheath forming part of the lever. The tubes rest on the paper, then, by their own weight. They are filled with a very fluid ink, which flows out through capillarity and leaves a very fine line on the paper.

The paper band finally exhibits a series of indications which show the curve of velocities, the curve of tractive stresses, the mileage, the time, and the number of revolutions of the wheels.

When all these elements have been obtained, the figurative curve of the velocity is traced as follows:

On the ordinates of the line of the time, lengths are laid off proportional to the spaces traversed in an interval of 10 seconds, in taking for scale 1 millimeter per kilometer per hour. The value of such space is obtained by counting the number of revolutions of the wheels that have occurred during the same time (10″).

The curve of the velocities once obtained, the positions of the stations, mile posts, and switches are fixed by the tracing given by the style, *b*. The velocity is then known at which these points were passed.

A profile of the road is also traced, so as to permit of judging at a glance of the influence that such profile may have on speed and tractive stresses.—*Annales Industrielles.*

SETTING SLOPE STAKES.

To the Editor of the Scientific American:

I wish to submit, through the medium of your columns, to the engineering profession "a short method of setting slope stakes by the use of the hand level." This new method is original with myself. It does away entirely with the "height of instrument" and "width of road bed" in the calculations, requires only the engineer and one assistant, 50 foot tape measure, hand level, and self-reading rod.

To the zero end of tape must be attached a wire (or other suitable material) equal in length to one-half the width of road bed.

The rod must be graduated as follows: Zero at five feet from lower end, thence to be graduated in both directions to feet, tenths, and five-hundredths (Fig. 1). At lower end

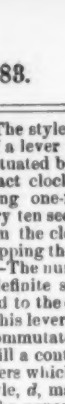
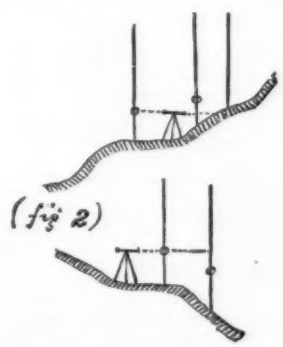


FIG 1.

must be an extension shoe to allow the zero to be adjusted to exact height of the eye of the person using the hand level.

I will first explain the use of the rod, and then show its application to railroad work.

Suppose, for instance, that the foot of the rod be placed on a point level with the point under the heels of the "leveler," the reading on the rod will evidently be zero or 0·0. (Fig. 2.) Now if the rod be moved to some point two and a



half feet below that of the leveler, it is evident that the reading will be 2·5, giving actual difference of level, without bringing into consideration the "height of instrument." The same will be the case if the rod be moved to some point two and a half feet above that of the leveler; in first instance the reading will be from *zero* up; this we will call *minus*. In second case it will be down; call *plus*.

Now for the application:

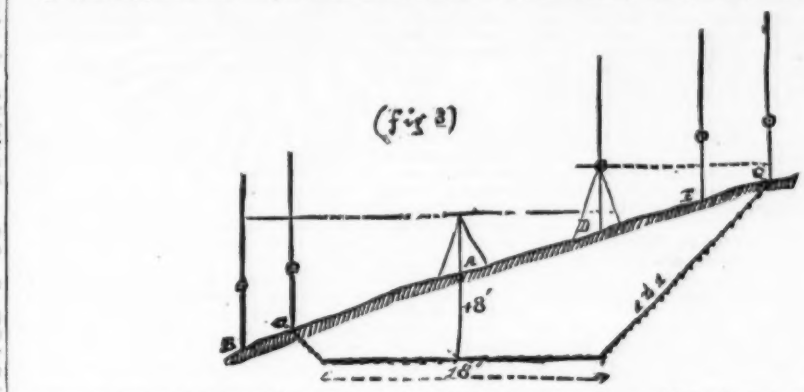
Take the case of an excavation in which the center cut is 8 feet, width of road bed 18 feet, and side slope one to one. (Fig 3.)

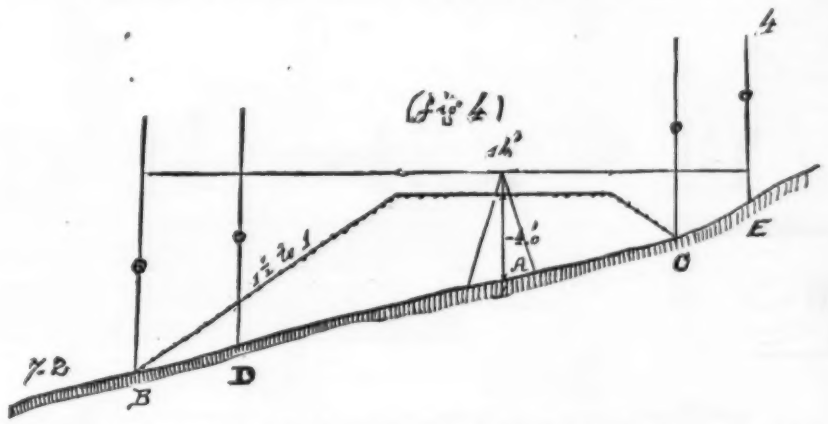
The wire (or other material) attached to tape will be nine feet long. This will throw out of consideration the "width of road bed," making our horizontal measurements begin at the foot of "side slope." The leveler places himself directly over the center stake, A, the assistant taking the end of wire (with suitable handle) attached to tape, goes out to left to some point, B. Suppose the rod to read here —3·5, and tape in leveler's hand, held even with center stake, to read 7·5; then + 8·0 — 3·5 = 4·5, hence we see at a glance that the rod is too far out. Rod moves in to C, where it reads —2·75, tape reading 5·25; then + 8·0 — 2·75 = 5·25, correct position.

Again, for opposite side stake, leveler remains at A, assistant goes to D (should it be evidently impossible to sight to position of stake at once, the tape is made to read "zero"), where rod reads +4·7, then height of D above road bed = +8·0 + 4·7 = +12·7, this to be now used instead of C C. Leveler moves to D. Assistant now takes tape at zero, discarding the "wire attachment," and goes to E; here rod reads +4·3, tape reads 15·0, then +12·7 + 4·3 = 17, hence rod too close. Rod goes to G; there reads +4·8, tape reads 17·5, then +12·7 + 4·8 = 17·5, correct.

Now to apply this system to embankment. Suppose cross section as follows: Road bed 14 feet, center fill 4 feet, side slope one and a half to one.

Attachment to tape taken up to 7 feet (Fig. 4). Leveler at A, rod at D reads —2·0, tape reads 7·2, then —4·0 — 2·0 = —6.





Now since slope is 1½ to 1, we have 6 + 3 = 9, hence rod is too close.

At B, rod reads —5·8, tape reads 14·7, then —4·0 — 5·8 = —9·8, and 9·8 + 4·9 = 14·7. Correct.

Same process for other side stake.

It is useless to go further into detail; the foregoing will sufficiently explain the true spirit of the system.

In my experience I have found this system to be far simpler, less liable to errors, and more expeditious than the common use of the Y level for this work.

With a little practice the leveler can, by watching the tape as it passes through his hand, and at the same time having care to the rod, stop the assistant at the exact position at once. Trusting that this may be of advantage, however slight, to the division engineer and those engaged in such work, I offer it merely as a small addition to the many practical usages of the engineering profession.

PAUL MCCOMBS, C.E.,
Chief Engineer H., N. O. & W. T. Railway.
Huntsville, Texas, 1883.

THE PLANT OF THE WOOD RIVER SMELTING COMPANY.

WE give from the *Mining Record* a sketch of the works of this important smelting company, established at one of the most promising mining centers of Idaho, for the purpose of converting into bullion the abundant ore product in that quarter. We have many times pointed out in our pages the urgent need for the establishment of such metallurgical works upon the same footing, with respect to ores of the precious and superior metals in the vicinage, that a flouring mill has with respect to the wheat grown around it. We have also as frequently urged capitalists to embark in such undertakings, as certain, when properly managed, to result in large profits upon the expenditure, while at the same time affording essential aid in the development of the mineral resources of the country, in which all our people are so deeply interested. The works of the Wood River Smelting Company are precisely of this character, and can scarcely fail to be a profitable enterprise for the stockholders, while being of great value at the same time to the mine owners, and a most important factor in the development of the mineral resources in the quarter of their location.

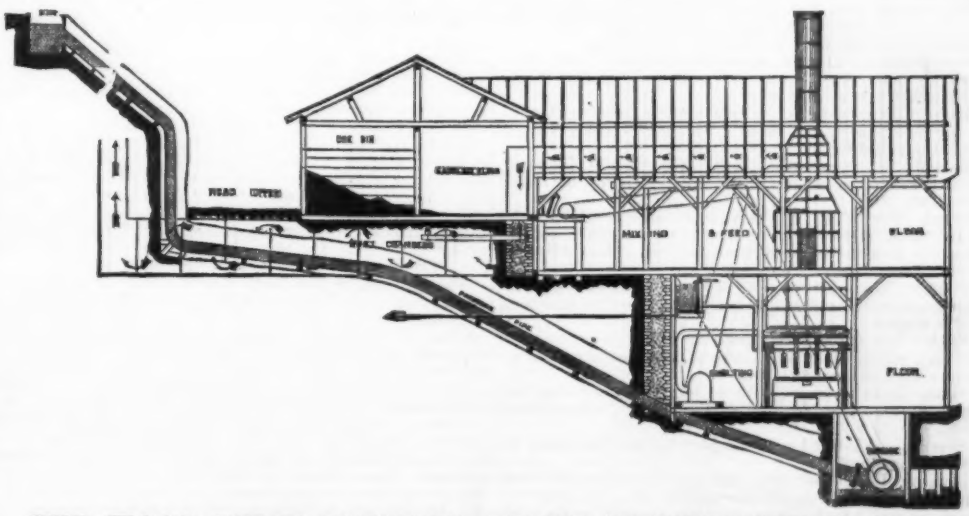
The following details in this connection have been furnished by the superintendent:

1. *Location.*—The works are situated about three-quarters of a mile from the town of Bellevue, Idaho, and about half a mile from the projected route of the Oregon Short Line Railroad, from which point they are approached by wagon roads on level ground.

Their advantageous location at the gate of the Wood River mining district, as well as the close proximity to the rapidly advancing railroad, will have a decided tendency to render their business opportunities superior to those of other works in this section of country. The delivery of coke, fluxes, and supplies, as well as the exportation of bullion, can be effected directly without transfer to wagons, by means of a side track from the main line, conducting directly to the smelter. The iron mines of the company are about three miles distant, from which iron ore is being transported over substantial roads at $3.00 per ton.

The two mill sites on which the works are built, ten acres in area, embrace a foothill of Lookout Mountain, the topography of which secures good contours for buildings, as well as bottom land for storing supplies and gaining adequate dump room for slag.

2. *Divisions of Plant.*—The smelter proper comprises, besides the smelting floor 30x80 feet, and a feed floor 30x45



THE WOOD RIVER SMELTING WORKS AT BELLEVUE, IDAHO.

feet, 15 feet above the former, an additional building 25x50 feet, six feet above the feed floor, where the weighed ores are stored in bins, and after sampling and purchase drawn off in the proportion required by the smelting mixtures. A wing on the south side of the main smelting building projecting ten feet and running back twenty-four feet covers the motor, which is a Knight turbine, three feet diameter (vertical reaction wheel).

Between this wing and the upper building there is a space of ten by fifteen feet, which is divided in two compartments, the one for receiving crushed iron ore flux, the other designed for crushed limestone flux.

To the right and left (north and south) of the sampling department are fuel bins, which are filled from the upper ore-road, their contents being drawn off by cars, and trammed and dumped to the front of the smelter on the feed floor just before the furnace. Thus the smelting supplies necessary for the reduction process, as well as the sampled ores, are all centered around the furnace on the feed floor, where they are made into beds according to metallurgist's computations, and the charges fed to the furnace. The entire plant has been projected and built on the terrace or gravity plan, the movement of the ore in process of handling and treatment being always down. The turbine wheel is placed under the floor out of the way, and from its shaft two stationary pulleys transmit to the main working shaft, which in turn imparts motion to the blower, elevator, crushers, and sampler.

The fall is fifty-seven feet, and the available force fourteen-horse power, when turning 100 miner's inches into the ditch.

The pressure pipe is about 100 feet long, and has a diameter of thirteen inches.

As the company's water right gives them title to 300 miner's inches, conducted in a ditch 460 rods long, the conditions are at hand to increase the available power at any time, by placing in a wheel of a larger capacity and utilizing the full amount of water. A tap in the main pipe conducts water into a supply tank fourteen feet above the smelting floor, from whence the water jackets are fed.

A five-inch hose is set into the ditch tank, which can be turned out and used as hydrant in case of fire.

The furnace is of the sectional water jacket pattern, and has a capacity of between twenty-five and thirty tons, which includes ore and fluxes. It resembles closely those in use at the Germania and Horn Silver smelters near Salt Lake City, Utah, at which place it was built. The advantages of the construction are the following:

First. The water jacket being in sections, can be removed at any point where most worn. This can be done without being compelled to run completely down.

Second. The lower part of the furnace can be easily got at to remove accretions or for repairs, without having to tear down.

Third. The brick, of which the furnace is chiefly built, is the most refractory and durable of materials, and retains the heat in the walls, thus preventing the chilling of the furnace.

Fourth. The materials of construction are easily obtained, are cheap, and repairs can be made by the mason as fast as needed.

Fifth. The furnace surpasses all others in economy of working, giving clean slags, which need less flux, and effecting a notable saving of fuel.

Sixth. It is arranged with an improved dust chamber, where the fine ore, blown from the furnace, is caught and saved.

Seventh. It is fitted with a siphon tap and lead basin for giving a clean bullion.

Eighth. Two offset doors on opposite sides give convenient access to the interior for barring off. The accessory buildings are: 1st. A blacksmith shop, situated to the south near the smelter. 2d. A general business office, opening into an assay office and laboratory. 3d. A weigh house covering a five ton Howe scale, which is manipulated from the office building.

3. *System of Operation.*—The ores suited to domestic treatment, as well as the fuel and fluxes, after accurate weighing by the wagon load in the scale house, are unloaded into their respective bins from the upper road, the empty wagons passing on down again over the scale. After sampling and settlements, they are either passed back into the bins or passed through crushers, which discharge into the feed floor, where they are arranged in beds in suitable mixture, and fed to the furnace with fuel and fluxes.

The furnace manipulations are carried on on the smelting floor, where the bullion and slag are drawn off. The latter, if requiring further impoverishment or desirous as flux, is transferred by the car load into an elevator, and raised twenty-one feet back to the sampling level, where, after crushing, it passes into ore mixture with the raw ore.

FREDERICK G. CORNING, Supt.

WELKER'S PERCUSSION ROCK-DRILL.

EVERY rock-drill should be able to perform the four following operations: (1) The percussion of the tool designed to pierce the rock. (2) The rotation of the said tool, so as to present its cutting surface successively at all points of the bottom of the hole. (3) The forward movement of the tool-carrying cylinder in measure as the hole deepens, so that the piston may always be in the same relative position with it. (4) The recoil of the cylinder on its bed.

We show in the accompanying plate an apparatus that well fulfills all these conditions, this being a modified form of the rock-drill used in excavating the St. Gothard tunnel.

The apparatus is shown in elevation in Fig. 1. The tool-carrier is shown in plan view in Fig. 2, and in transverse section in Fig. 3. Fig. 4 is a longitudinal section of the mechanism, and Fig. 5 gives a plan view of the same. Fig. 6 gives an end view of the apparatus. Figs. 7 to 9 show transverse sections made respectively on the lines 1–2, 3–4, and 5–6.

The mechanism in general is carried by two longitudinal steel supports, A, of rectangular section, which are connected behind by a piece, a, that serves to fix the machine to the frame, and in front by a piece, a^1, which serves for the same purpose, and also as a guide for the tool-carrier.

The percussion apparatus is formed of a bronze cylinder, C, capable of moving backward and forward on the supports, A, which, in this apparatus, have smooth faces and are not provided with racks.

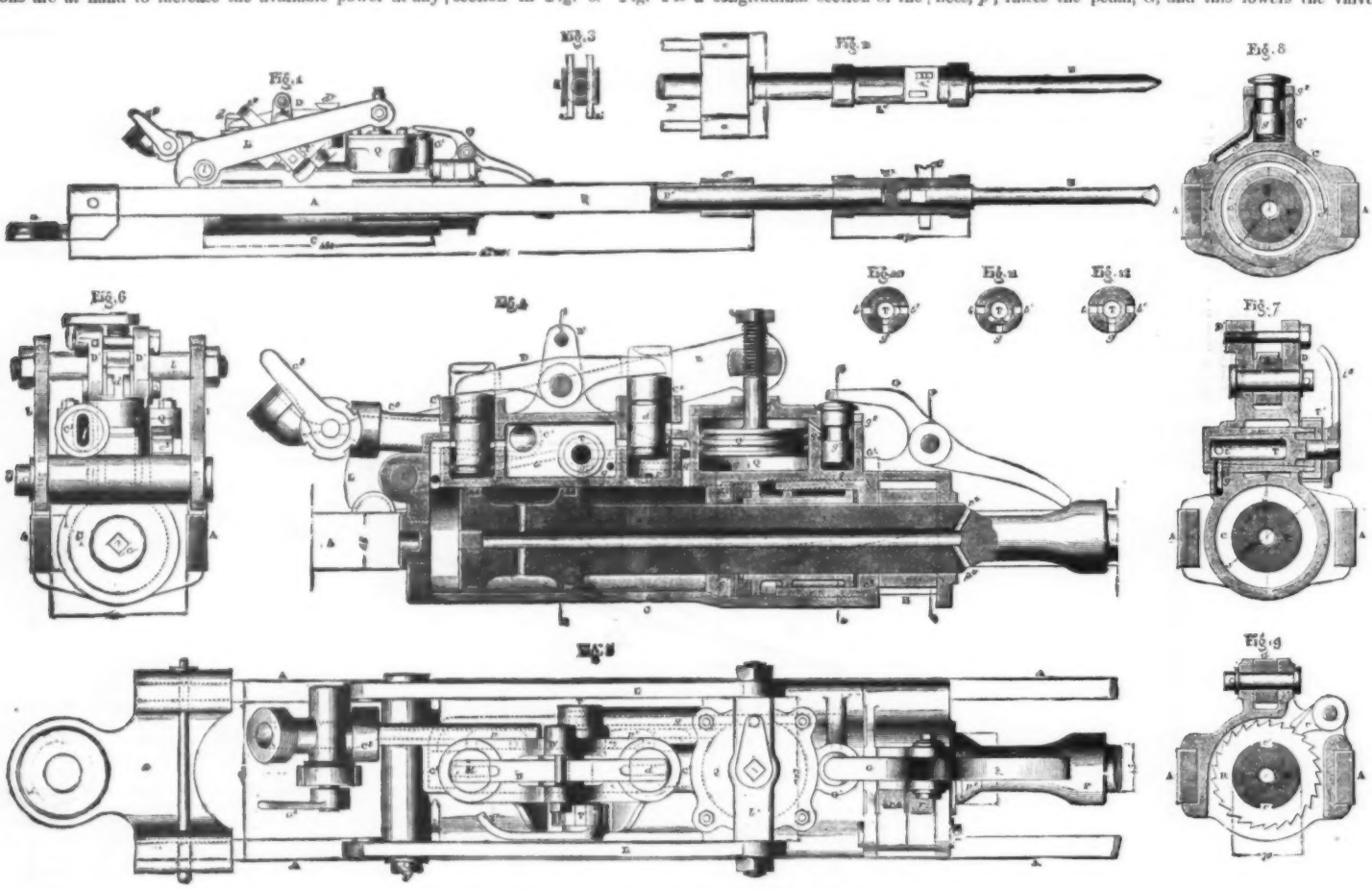
In the cylinder, C, there slides an iron piston, P, which is hollow throughout its entire length and is prolonged by a cylindrical rod, P^1, at whose extremity is fixed the drill, Z, through the intermedium of the sleeve, Z^2, and the two keys, z^1. This cylinder is closed in front by the stuffing box, c^2, and behind by the screw plug, c, and, in a piece with it, is cast the distributing cylinders, C^4, connected by the chamber, C^1, in which ends the pipe, C^2, that leads the compressed air. The entrance of the latter is regulated by a cock, c^3.

The cylinder, C, also carries two pieces, D^1, that are traversed by the axle of a sort of walking-beam, D, whose forked extremities are in contact with the head of the distributing pistons, d. The rotating mechanism of the drill is identical with that in the Ferroux rock drill, mentioned above as having been used in the St. Gothard tunnel. The propelling apparatus for causing the automatic forward motion of the tool differs completely, on the contrary, in the two apparatus. It consists, in the machine under consideration, of a vertical cylinder, Q, cast in a piece with the percussion cylinder, C, and in which moves the piston, Q^1, covered with segments of steel. This cylinder is closed, and communicates with the air-chamber through a small conduit, q. As for the piston, Q^1, that acts, through its rod, q^1, and the cross-piece, l, upon the levers, L, that are pivoted on the pin, l^1, and thus fixes the percussion cylinder upon the supports, A, by means of two small hemispherical steel sliders.

Operation of the Apparatus.—The compressed air, conducted by the pipe, c^2, into the chamber, C^1, is distributed by the pistons, d and d^1, alternately one side and the other of the piston, P, and follows the small channels, p, that are indicated by dotted lines. It should be stated here that the hollowed part of the piston between the two faces is in communication with the external air through the interior of the rod, P^1, and channels, p^2.

Fig. 4 represents the percussion piston at the end of its back travel, the distributing pistons being so placed as to give admission to compressed air through the conduit, b, to the back of the cylinder, C, and an escape through the conduit, b^1, in front of the same cylinder. The compressed air entering thus behind the piston, p, forces it out; and, when the latter uncovers the orifice of the conduit, p, it leaves free the access of compressed air to the under surface of the piston, d, which is thus forced upward. It permits, moreover, of the evacuation, through the conduit, p^1, and the interior of the rod, P^1, of the air contained beneath the piston, d^1, which is thus allowed to descend. The distribution is thus reversed, there occurs an escape of air behind the piston, and an introduction in front of it, and the piston moves back until it regains its first position. At the same time that it is moving backward the piston, P, revolves slightly. We shall now see how the automatic travel of the percussion cylinder is effected.

We have said that the compressed air, coming in constantly through the conduit, q, under the piston, Q, raised the latter, since the bottom of this piston was in communication with the external air through the conduits, q^1 and q^2. When the drill, Z, penetrates deeper into the rock, it no longer occupies the same position with respect to the cylinder; for then the conical part of the rod, P^1, near the orifices, p^3, raises the pedal, G, and this lowers the valve, g^1,



WELKER'S PERCUSSION ROCK-DRILL.

which is held up by a small spiral spring interposed between it and the bottom of the small cylinder, G^1. As a result of this depression of the valve, g^1, the orifice, g^2, is closed and the compressed air enters under the piston, Q, by passing through the cock, T, the conduit, g (shown by dotted lines), the interior of the valve, g^1, and the channel, g^3, thus permitting of the pressure being balanced, which is exerted under the piston, Q, and of unlocking the levers, L. To this end, the cock, T, must occupy the position shown in Figs. 4 and 10.

The pressure, acting then simultaneously upon the surface of the percussion piston, and upon the front end of the cylinder, brings about a forward motion of the latter. In fact, the cylinder being free upon the supports, A, in consequence of the unlocking of the levers, L, and its mass being less than that formed by the combined percussion piston, the tool carrier, the sleeve, and the drill, it advances, instead of the piston recoiling until the conical part near the orifices, p^3, has left the pedal, G.

In order to effect the recoil of the percussion cylinder, the cock, T, is so maneuvered as to put in communication the channel, g, and the conduit, t. This position of the cock, T, is the one represented in Fig. 12.

Every time that there is an introduction from behind, and that the cone, p^3, has raised the pedal, G, the small valve, g^1, will descend, and the compressed air from behind the percussion cylinder will enter beneath the vertical piston, Q, and balance the pressure exerted there. Consequently, the levers, L, will unlock, and the machine will recoil from the same causes that drove it forward. In Fig. 11 is indicated the position of the cock, T, for stoppage.

Against the rod of the piston, Q^1, there rests a tightening screw, which is maneuvered by a small winch that is turned back when the machine is running, and which serves at the same time as a brake. When a slight wear of the sliders occurs, it is compensated for by the screw.

The two spaces occupied by the air over and under the

piston, Q^1, are unequal. The rod, in fact, occupies a certain space that diminishes by just so much the volume of air contained beneath the piston; and the result of such an arrangement is that, the piston, Q^1, not being completely balanced, the levers, L, always exert a certain stress upon the supports, A, this being necessary to prevent any slipping of the apparatus when it is working in an inclined position.

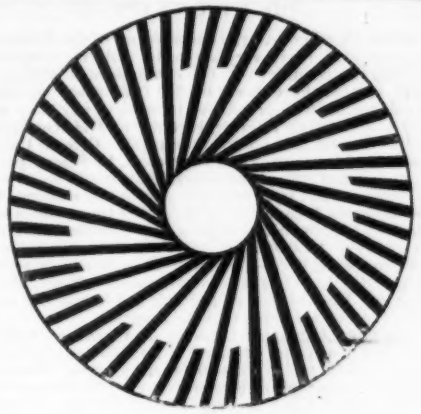
The principal dimensions of this machine are as follows:

Diameter of percussion cylinders	0·106 m.
Stroke of piston	0·08 m. and 0·1 m.
Diameter of rod	0·75 m.
Length of apparatus	2.1 m.
Width " "	0·2 m.
Weight " "	200 kilogr.

The velocity of percussion varies with the pressure of the air. With a pressure of 2½ atmospheres, it is about 400 strokes, and the work progresses at the rate of 0·15 m per minute in granite, and about 0·25 m. in schists.—*Machines, Outils et Appareils.*

MODEL MILLSTONE DRESS.

OUR engraving gives what Mr. Corcoran, the well-known millstone maker of London, Eng., regards as a model dress. He says: "The wheat is supposed to be gently split open by the points of the eye-lands, each half spread out flat by the widening face of the same, which should be kept as smooth as glass, and finally, the thick bran scraped clean by the last seven inches of sharp cutting skirt. The action should be uniform, as every furrow has the same drift, and therefore they all cross each other at the same angle.



DIMENSIONS.

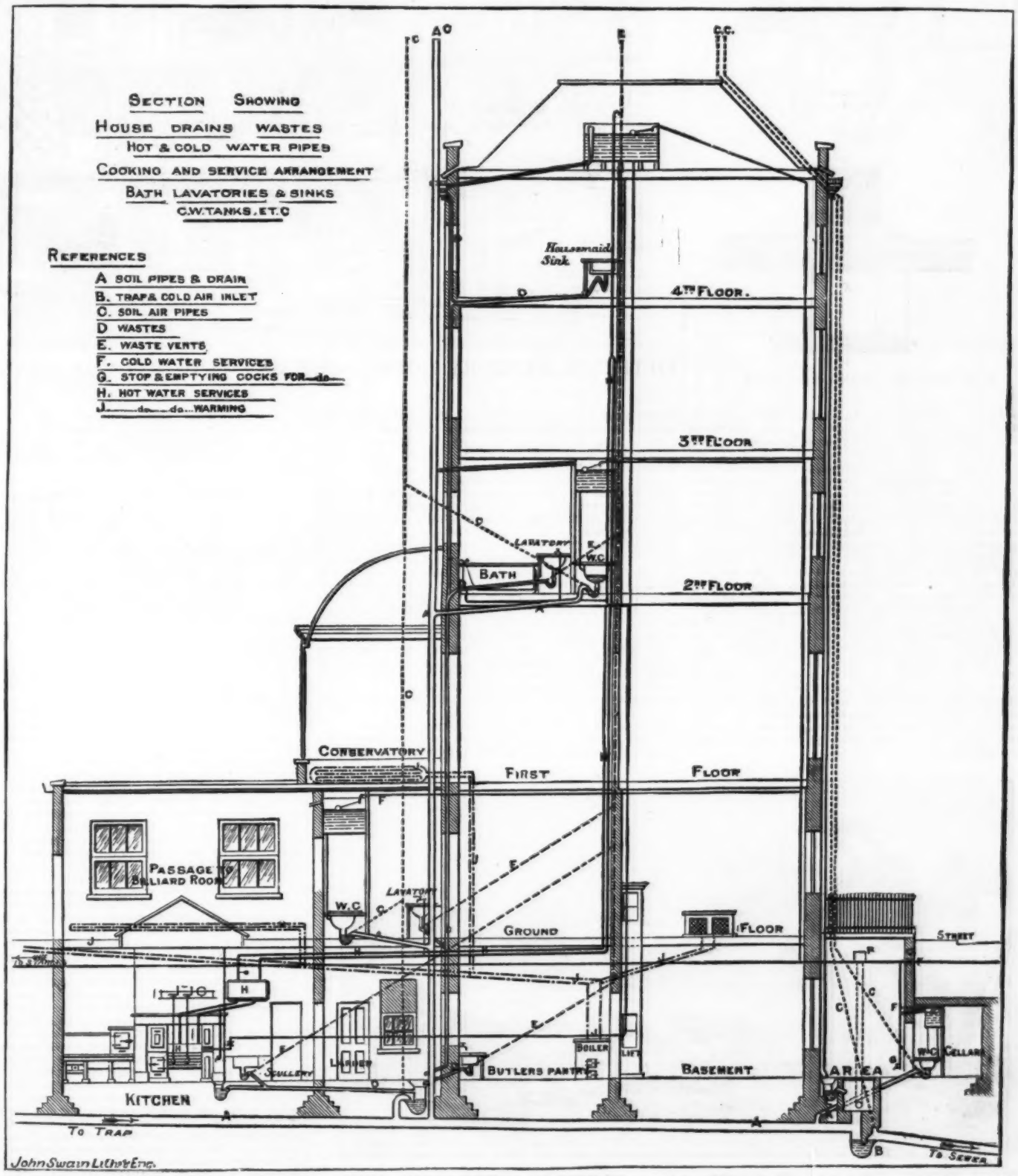
Stone	4 feet.	Eye 12 inches.
Eye-burrs	11 inch ring of	hard white burr.
Bedstone skirt	7 " "	close violet "
Runner skirt	7 " "	free nutmeg "
Bedstone	To staff all over.	
Runner	To staff 7 inches in breast and eye-burrs, gradually depressed ⅛ inch.	
Twenty-four leading furrows	All ⅛ inch deep throughout	
Twenty-four intermediate furrows	All 4 inch to *back* edge.	

"I do not claim to make a great excess of middlings over any other dress while cleaning the bran, but that while we get rather more in quantity, they are much more even in size, with fewer large ragged semolina than the quarter dress would give. For half furrow and half land in a four foot stone, the forty-eight furrows should be one and a half inches. The white represents the 'lands' which lead right up to the eye, and the shaded lines the leading and skirt 'furrows.'"

SANITARY APPLIANCES FOR DWELLINGS.

THE engraving below illustrates an arrangement of sanitary appliances as designed by Mr. F. Botting, of 29 Mount street, Grosvenor square, London, for dwelling houses. At B in the lower part of the building is an air-tight inspection chamber, as already illustrated in our pages. Through the mica inlet valve over it at P fresh air descends, and passes along the drain and up the soil pipes and vent, A. It will be seen that the drain is free from any other traps except at the water-closets and gullies, but these do not impede the flow of air. The soil traps are all ventilated into a separate pipe and the waste traps, the pipe for which is shown in the center division wall.

All the wastes discharge over a gully, and the cistern overflows into the open air. The water-closets have outlets also, though these are not shown. The cold-water pipe and tanks are all inside the house, so as to prevent freezing, and as a further safeguard, a tap is fixed in the area for emptying the pipes when the cisterns are full. The hot-water service pipes are connected with an accumulator, shown at H, in the kitchen; this prevents the necessity of any men being employed upstairs during repairs. The cold service is attached direct to the boiler, and the accumulator, H, being so near, no safety valve is required, as, although this supply may choke also, the argument is that it would be observed



ARRANGEMENT OF HOUSE SANITARY APPLIANCES.

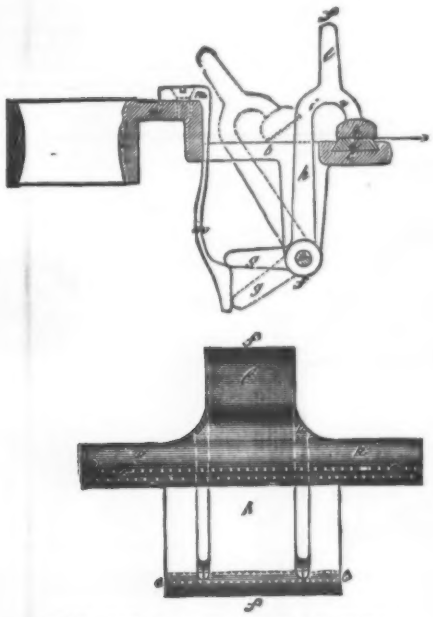
by the diminution of the supply. The old system is, however, retained, a tank at the top being employed as shown, as it forms an airing closet, which would otherwise need a special coil attached to the pipes. For the hot-water warming pipes a boiler is, for convenience, shown in the pantry. It is proposed to use gas here, as the quantity of heat required is less, because it is constant and can be easily regulated.

No service hot closets are shown, but two are needed, one in the kitchen and one outside the dining-room near the lift, which in large houses is worked by a small ram, the waste water passing, if necessary, into a tank in the scullery or elsewhere for washing purposes.—*The Engineer.*

CLIP FOR TENTERING MACHINES.

OUR present illustration shows an arrangement of a clip for tentering machines recently patented abroad by a Saxon machine maker who has acquired a considerable name in his neighborhood for this class of machinery. The object of all clips on tentering machines is not only to hold the selvedge of the cloth during the process of drying, but also to retain this hold in such a manner that the cloth does not tear or slip when it is a little narrower or wider, as usual, and thus to produce a more or less elastic gripe, similar to that produced by holding the selvedge with finger and thumb. Clips have moreover this advantage over gill pins, that they leave no marks in the cloth.

The body of the clip represented consists of a casting, *b*,



CLIP FOR TENTERING MACHINES.

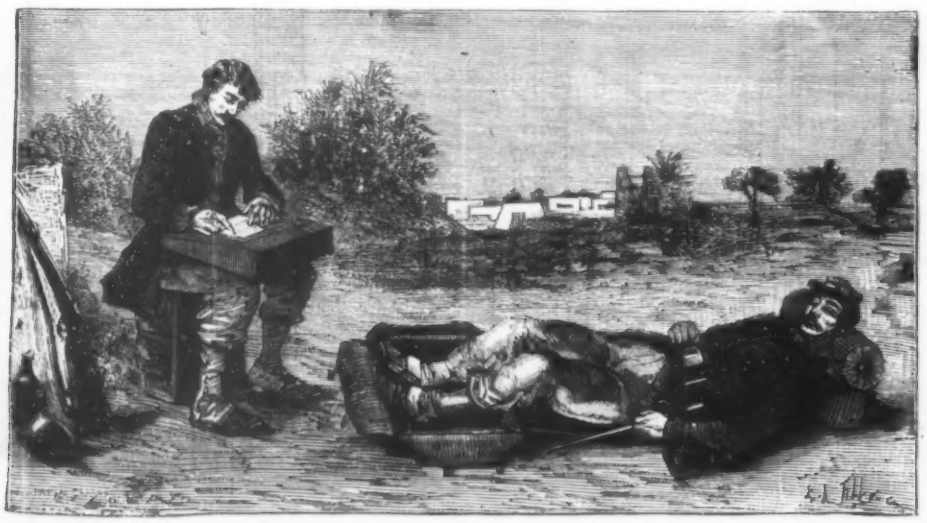
attached to the usual links, *a*, of a traveling chain; to the inner end of this casting is bolted the lower jaw, *c*, into which is dovetailed the piece, *d*, made of brass or wood, according to the nature of the cloth to be held. The lower end of the casting, *b*, contains a stud, *e*, which serves as fulcrum to a bell crank lever *g h f*; the upper arm of this lever contains a jaw, *k*, corresponding to the lower one, *c*, and between which two the cloth is held, while the upper end is elongated in the form of a handle, *l*, to enable the attendant to open the clip when required. To the link, *a*, there is also bolted a spring, *m*, of a peculiar construction, which terminates at its lower extremity in a lip, which latter presses against the lower arm, *g*, of the bellcrank lever; this is shown with the jaw both closed and open, the latter in dotted lines. If now, by an arrangement in the machine, the upper arm, *l*, is pushed forward, and the jaws closed, the lower arm, *g*, will be pushed to the upper edge of the lip of the spring; the latter will then exert its power and push it over the upper edge, and in this way hold the jaws together, but with sufficient elasticity to allow the cloth a little play. As the pull of the cloth is exerted in the direction of the arrow, it follows that the upper jaw will have a tendency to follow it; but as it does this, it at the same time presses more upon the lower jaw, and thus holds the cloth so much firmer. The jaw is opened mechanically, in the usual way, by the upper arm, *l*, passing at a given point over a stud, which pushes it a little back. —*The Textile Manf.*

THE DESK KNAPSACK.

FOR a long time past the management of the French army has occupied itself very seriously with the subject of improving the condition of non-commissioned officers. One after another have been studied the great questions of re-enlistments with premiums, increase of pay, etc. Certain details and certain reforms reaching the same end, although of less interest, are not to be despised. General Campenon has proved this, apropos of equipment, by relieving the non-commissioned officer's knapsack of a considerable weight of cartridges. But in removing a part of the ordnance from it the knapsack became too large; and, if the vacant space was filled with a few useful objects, the cartridge compartment was thereby rendered too narrow. A modification, therefore, suggested itself—the suppression of the useless compartment. A young non-commissioned officer, M. Albert Bergeret, has just devised a simple and ingenious improvement that we are going to make known.

The present knapsack consists of a frame of light wood, of rectangular form, provided at its upper part with a small piece of wood which closes the cartridge-box. The place reserved for this purpose occupies nearly $\frac{1}{3}$ of the total volume, and affords a space of only 4 to 5 centimeters in height in the whole width of the sack. It is this wooden cover that is done away with in the new model, to be advantageously replaced by a desk compartment of a size equal to the old cartridge box, but of a greater superficies. This new model, increased by an insignificant weight (40 or 50 grammes) by the addition of this desk, gains in the advantages of convenience and strength what it loses in weight. It is, in fact, more convenient, since it permits the officer to have with him certain very useful objects that he, perhaps, could not have carried in the other, and without their being spoiled as before by contact with brushes or shoes. It is stronger in that its frame is formed of two pieces of wood adjusted by tenons, thus allowing the man to use it as a seat without fear of breaking it, as often happened with the old style of frame, which was adjusted at three angles only, the fourth being left free for the introduction of cartridges on lifting the flap. This is not all; the non-commissioned officer often has need to use his pen or pencil to make a report, to copy an order, etc., and he cannot always find a favorable object to rest on. Here the desk knapsack will prove especially useful to him; since, resting it on the ground or on his knees, he may use it as a desk on which he can freely write or draw. And now, since we have undertaken to eulogize it, we may cite as a final advantage the use that it may be put to as a couch. Divested of its case and opened to its full extent, it offers an inclined plane which may serve as a headrest, the rolled up pantaloons being used as a pillow. Besides this, the case, when its flap is turned back, will serve to protect the officer's legs against the hardness, uncleanness, or dampness of the ground.

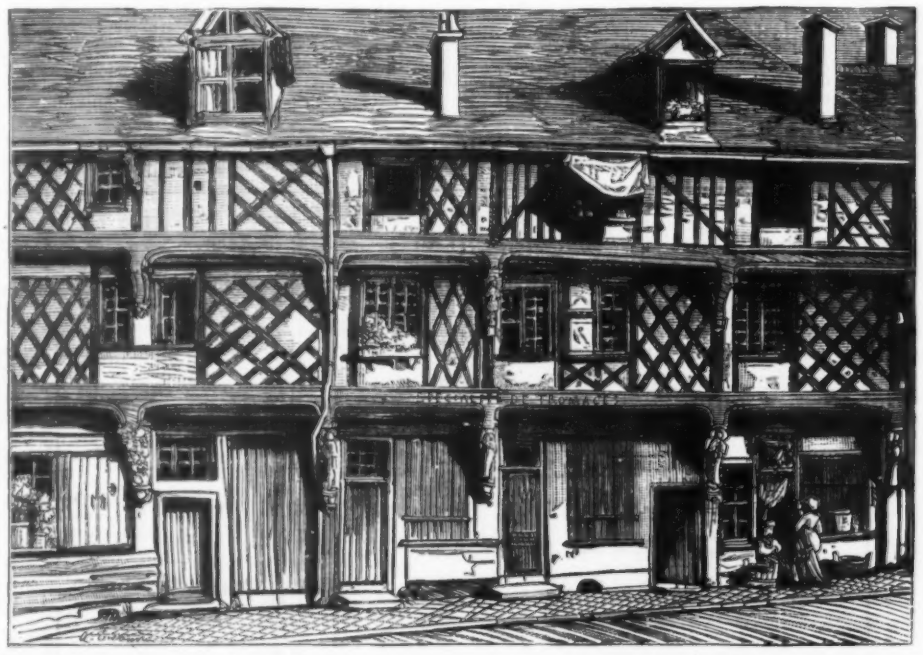
By a modification of the old style of fastening, so as to do away with some eighteen buckles and straps, a great gain is made in the time taken to fill the knapsack, as well as a great saving in the cost of manufacture.—*La Nature.*



THE DESK KNAPSACK USED AS A WRITING DESK AND BED.

HOUSES OF THE FIFTEENTH CENTURY AT CHARTRES.

IN the provinces of the west of France there still exist some wooden houses of the fifteenth century, but they are unfortunately tending to disappear from year to year because of the needs of our own epoch. The *Maison du Saumon*, situated near Place de la Poissonnerie, at Chartres, is a remarkable example of these. Its corbels are not exaggerated, and the neighboring structures contribute to give it a picturesque aspect. The other carvings are almost entirely ruined, and it is difficult to recognize their meanings. One bracket, however, represents pretty well vine leaves and bunches of grapes. These carvings sufficiently betray the professions of their old owners of the fifteenth century, and Place de la Poissonnerie still gives an idea of what a fine and well patronized market of that epoch must have been. It has seemed to us that it would prove of interest to give a sketch of it, so that it may be compared in imagination with our modern markets, which, although doubtless more convenient, leave much to be desired from the standpoint of the picturesque.—*La Nature.*



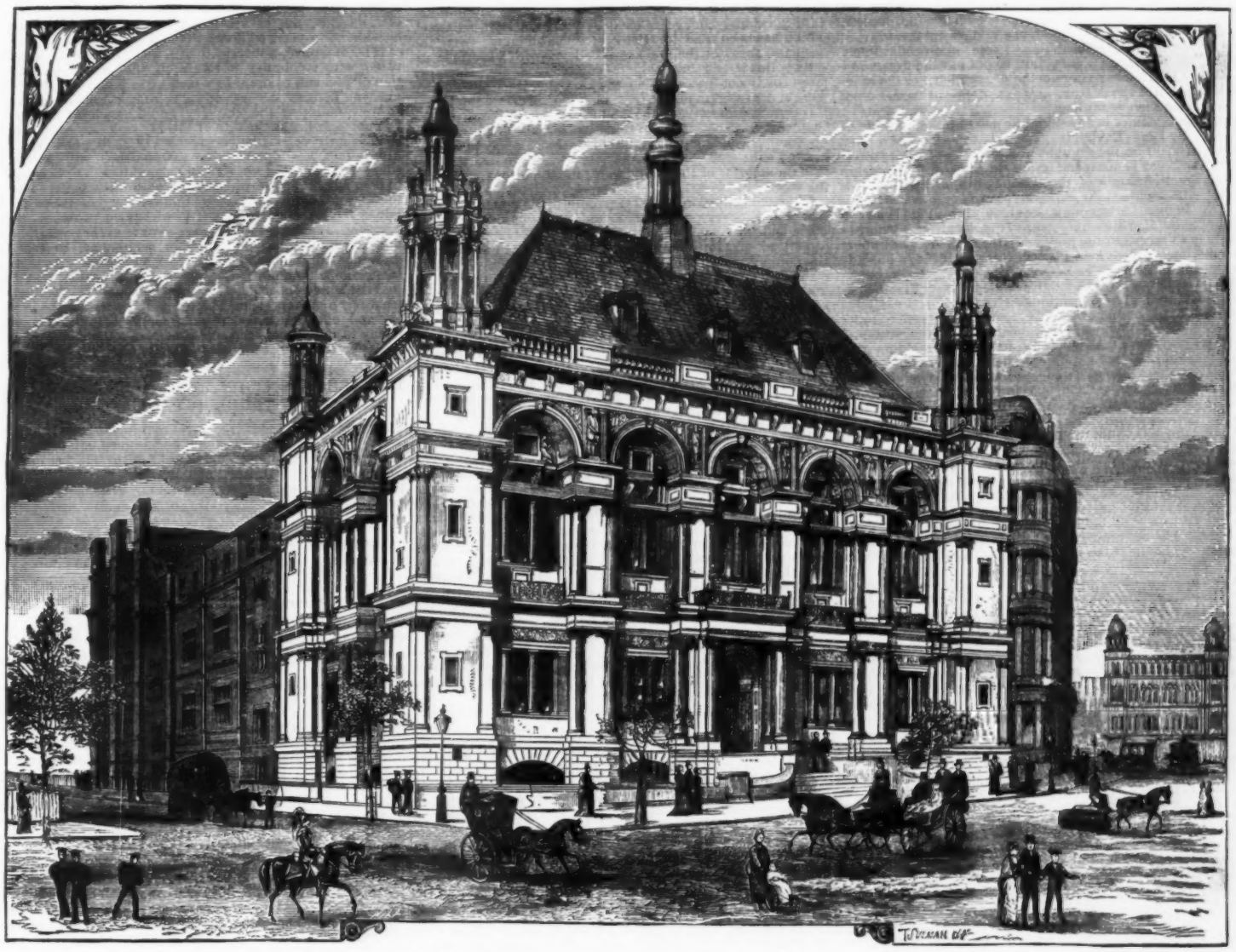
FIFTEENTH CENTURY HOUSE.—THE MAISON DU SAUMON, CHARTRES.

CITY OF LONDON NEW SCHOOL.

THE City of London New School, built on the Victoria Embankment, near Blackfriars Bridge, was lately opened by the Prince and Princess of Wales. Messrs. Davis & Emanuel are the architects of this really handsome edifice. The site of the building is an irregular oblong, having a frontage of 136 ft., facing the Embankment, and a depth next the new side street of more than 430 ft. The surface of the site of the building is entirely composed of made ground, which has been filled in at various dates at the back of retaining walls, as successive belts of the foreshore have been reclaimed from the river. The remains of two old retaining walls of early date were exposed by the foundations, the excavations for which were very extensive. The site, too, had largely consisted of the circular excavations which received the former gasholders, and care has been taken to carry the whole of the foundations to a somewhat greater depth than the side walls of the underground railroad tunnel, which passes below the site, so as to reduce as far as possible the inevitable vibration arising from the passing trains. All the foundations of the school building are carried to an average depth of 28 ft. below the level of the school play ground, and large rectangular holes were sunk through the made ground down to a bed of Thames ballast, which was met with at that level over the whole site, and which doubtless formed at one time the bottom of the river. The holes were then filled in with Portland cement concrete up to a level of 30 inches below the surface of the play ground, so that the school building stands on a series of concrete monoliths more than 25 ft. high, and ranging from 10 to 15 or 16 ft. square. These foundation works were therefore very heavy, and consequently costly. The bed of ballast before mentioned is by no means thick, and an attempt was made in the first instance to reach, by boring, the London clay; but immediately beneath the bed of shingle there exists a bed of quicksand, which it would have been extremely difficult to penetrate. This quicksand, too, being below low water mark, is always fully charged with water, and no risk to the building attends its existence unless in some future building or deep drainage works this quicksand should be cut by the excavations, in which case any heavy pumping would certainly cause risk of settlement to the school, as well as to the Royal Hotel adjoining, the foundations of which rest on the same bed of ballast. The foundations of the gymnasium, latrines, and boundary walls are carried to a small depth only, and rest upon compact made ground, which has doubtless been in position for a century. These out buildings being by no means heavy, are carried by a wide bed of concrete resting on this made ground. The whole of the floors throughout, except those to the porter's bed-rooms in roof, are fire proof, consisting of Portland cement concrete, filled in between rolled iron joists, which are spaced about 27 inches from center to center. The lintels throughout are made up of rolled iron joists, and an unusually large amount of constructional iron

work in girders and columns has been employed at the level of the ground floor, so as to avoid obstruction in the covered play ground, which occupies so large a portion of the basement beneath the building. The block plan is of a simple character. The building is L shaped; the shorter arm of the L facing the Embankment is three stories high, and contains: The great hall, entered from the first floor landing of the principal staircase. It is 100 ft. by 45 ft., with a handsome open timbered roof 38 ft. high, from floor to under side of tie beam, and 60 ft. high to the ceiling. It has a raised dais at one end, and a projecting gallery at the other, the entrance being on the side. There is a turret staircase in each of the four corners; those at the western end leading up to the gallery, those at the eastern end leading down from the dais to the administration rooms below. In the northwest corner is an organ chamber entered from the gallery, and containing a small organ by Willis, and beneath this is a small room for the storage of spare seats or plaster casts for use of the drawing classes. The floor is of oak, and the walls are faced with Portland stone. The wood work to all the lower portions of the hall is of American walnut. The roof, which is of pitch pine stained walnut, is an attempt to treat with classic detail the beautiful late-Gothic feature, an opened timbered roof. It is lighted by six dormer windows, filled in with stained glass of geometric pattern, and can be best seen by mounting the turret stairs to the level of the tie beams, and passing round the great hall by a passage way at that level. The large enriched cove at the level of the tie beams is of carton-pierre, colored to match the walnut wood work. It is lighted by eleven large seven-light windows. The two seven-light windows at the east end, behind the dais, will shortly be filled with stained glass. All round the room is a high walnut wood dado, and behind the panels of this dado, masked by cast iron ornamental gratings, are powerful coils of hot water pipes. Fresh air enters at the back of these coils, and passing over them becomes warmed before entering the room, the supply of fresh air to each coil being regulated by a valve on top of same. These coils of hot water pipes have been placed around the walls, instead of in channels beneath the floors, to obtain the advantage of such heat as may be radiated from the surface of the coils (or radiators, as the Americans call them) as well as the heat conveyed by the air passing over them, and to avoid the disadvantage of pipe channels with gratings beneath the floor, which invariably become receptacles for dust every time the floor is swept. The gratings in front of these coils, as well as all others throughout the building, are hung to open as doors, so that the pipes may be kept clean, and so prevent the unpleasant smell so frequently arising from hot water pipes. For artificially lighting the hall three large sun burners have been provided, and these will at any time give a strong motive power for drawing off the foul air from the ceiling. The body of the hall is fitted with permanent seats to accommodate 816 occupants. These, with the additional seats in the gallery and on the dais, make up the total accommodation which the hall supplies to about 1,000. The seats in the body of the hall are somewhat special in character, in order to accommodate the largest possible number, and leave free movement along the rows of seats. The actual seats are balanced and hinged to fold back, as at many of the theaters, but every alternate row of seats has a further movement by which the seat back becomes a desk for the row of occupants immediately behind it. Thus for a public lecture the body of the hall will accommodate 816, for a writing class half that number, 408, and for an examination, where more space is desirable, 204.

The administration rooms and library are on ground floor. Covered playground is on basement. The longer arm of the L, facing the new side street, which leads back from the Embankment to Tudor street, is the teaching block, and contains: Natural science school and lecture hall, and two class rooms on second floor. Eighteen class rooms on first and ground floors. Hat and coat room, dining room, and covered playground on basement. The gymnasium and latrines are detached buildings in the play ground. A common room and ante-room for assistant masters, a kitchen with its appurtenances, and apartments for the resident porter are provided in suitable places. The exterior of the hall block facing the Embankment is constructed entirely of Portland stone, but the columns of the windows have polished red granite shafts. It is in the style of Italian Renaissance enriched with carving and sculpture. The tympana beneath the arched heads of the first floor windows are filled in with allegorical seated figures representing various arts and sciences, and the wall spaces between these have square headed niches containing portrait statues of Bacon, Sir Thomas More, Shakespeare, Milton, and Newton. The facade is crowned by a balustraded stone parapet. Above this rises the great hall roof, which is a high pitched roof of French character covered with green slates and surmounted by a central fleche. This fleche, which forms the crowning central feature of the design, acts as the ventilator of the great hall. One object which this high roof serves is to prevent the school being overpowered by its gigantic next door neighbor, the Royal Hotel. The preliminary contract for the foundations was let by public tender, and carried out by Messrs. Higgs & Hill. The main contract for the building has been carried out by Messrs. John Mowlem & Co., and they have also executed a large proportion of the fittings throughout. Among the subcontractors employed by them may be mentioned Messrs. Measures, who supplied the constructional iron work; Mr. Mitchell, who supplied the marble work to the principal staircase, and Mr. Ebner, the marble mosaic floor of hall; Messrs. Jones & Willis, who executed the ornamental iron grilles at the front entrance doorway; Mr. Boekbinder, who executed the carton-pierre work in the cove of great hall; Messrs. Holden, who executed the copper work to the central fleche, with its wrought iron skeleton and dormers of hall roof; Mr. Boyd, who has supplied the class room grates, and Messrs. Steel & Garland, those for library and committee room; the Colebrook Dale Co. the pillar lamps on balustrade; Mr. Anderson the lightning conductors; Milner's Lock and Safe Company have supplied most of the locks and lock furniture; and Mr. Odell the stained glass. The School Committee have also obtained competitive tenders for, and have let separate contracts to—Messrs. Herring & Son, of Chertsey, for the hot water apparatus. Mr. J. F. Clarke, for the gas pipe work and sunlights; cooking apparatus and fittings; and sundry gas fittings. Messrs. Strode and Mr. R. H. Hughes for the more important gas fittings. Messrs. Daymond & Son, sculptors, who have carved the whole of the figure sculpture and the five statues in the niches round the frieze outside of great hall. The North of England School Furnishing Company, for the great hall and school seats and desks. Messrs. Story for the general furniture. Mr. Laurie, for masters' tables, blackboard, etc. Messrs. Willis for organ, and Mr. Spencer for the fitting up of gymnasium. It is not possible at present to state the exact cost of the building, but the total of the foregoing, together with the contractors' bills of extras and architects' commission, will make the total cost of the building works not far short of £100,000.—*Building and Engineering Times.*



CITY OF LONDON NEW SCHOOL

ON THE DRAUGHT OF CHIMNEYS.

THE attention of the Mathematical and Physical Section of the British Association was, on the 30th of August, called by their president, Lord Rayleigh, to the very humble practical inquiry as to the effect of wind on the draught of chimneys. It would be difficult more aptly to illustrate the true connection between the pursuit of pure science and the most everyday annoyances of domestic life (with a view to the removal of the latter), than is afforded by this announcement. As a prime feature in the architecture of dwelling houses the chimney demands a chapter to itself. And it is well that the basis of this chapter should be mathematical. With regard to draught, we have more than once had occasion to remark that it is a function of the height of the chimney tubes. We do not, of course, apply the remark without modification to the details of the ill-constructed chimneys. Many chimneys smoke from positive ill construction, having a narrow part, an ugly bend, or a downward portion in their conduit, which the normal draught is not strong enough to overcome. Others smoke because they form the shortest channel by which air can enter the house to supply the draught of the loftier chimneys. Where there are two chimneys in one room, and the doors and windows are closed, lighting a fire in one chimney will ordinarily cause downdraught in the other as the readiest mode of maintaining the atmospheric equilibrium. In most cases, however, the addition of a yard or so to the height of the chimney stack, supposing that to be already above the highest part of the interior of the house which it ventilates, will prove more useful than the addition of any of those curiously contorted and wholly non-pneumatic contrivances, the endless variety of which tortures the eye of the mechanically-minded man as he whirls along the suburban railways.

Apart from the questions of normal draught, and of internal regularity of construction, is the effect of wind on the draught of chimneys. This varies very much with the locality of the house. It may be said to be primarily a question of sight. Neither is it a question always to be settled, *a priori*, by the architect. The action of wind, although, of course, always determined by physical laws, is so subtile, and so delicately affected by slight causes, that there are cases in which it is all but impossible to foretell it. What is more common than to have a chimney that answers perfectly well, except when the wind is in one particular point of the compass? And why does it then smoke? To be able to reply

to this question is to be able to cure the defect: but how often is the difficulty regarded as insuperable? It may be useful to cite an instance of the deflection of wind in a manner that it is difficult to explain, and that could certainly never have been anticipated. On the lovely plain of Sorrento, sloping toward the Bay of Naples, in the midst of its own gardens and orange groves, stands a stately palace, which, in the days when the name of Nelson was a terror on the seas, was a favorite haunt of the Queen of Naples, and was not unfamiliar to our great sea captain. There are no rocks, lofty buildings, or overhanging trees in the immediate vicinity, and nothing that is apparently likely to interfere with the free movement of the wind from whatever quarter it may blow. The aspect of the front of the palace is northerly, looking over the Bay toward Naples and the hills behind it. On a few occasions—some three or four times, perhaps, in the year—a strong east wind sweeps across the peninsula, and is clearly indicated as to its cause by the straight and level stream of smoke that it drives from the cone of Vesuvius across the Bay. But on these occasions, the current is so deflected by the northern shores of the Bay, fully twenty miles distant, as to drive on the front of the palace; that is to say, in a direction pointing nearly due north with such force that it becomes necessary to close the *persiani*, or outer window-shutters, in order to preserve the great drawing-room windows from being blown bodily in. Full familiarity with the spot does not afford any very satisfactory explanation of the phenomenon, of which, however, we can speak from repeated personal observation.

This, perhaps, may be regarded as an extreme case. Nevertheless, it is typical of not a few instances in which currents may be detected after a house is built, the existence and effect of which the architect cannot be blamed for not having foreseen, but the influence of which on the draught of his chimneys will be, for so many days in the year, at once irresistible and intolerable. There is now absolutely nothing for it, in such a case, but to put out the fires. We do not say that a cowl may not be of use, but, on the other hand, we cannot speak from any experience of the action of a cowl under such conditions.

Here, then, comes in the scientific part of the question as attacked by Lord Rayleigh. What is the effect of a cross current of wind on the draught of a chimney? As the direction of the wind is more and more downward, his lordship replies, the up-draught of the chimney diminishes, but does not turn backward, that is to say, become down-draught, until the inclination amounts to about 30°. This is an important point at which to arrive. It is, however, obviously necessary to ascertain the precise features of the cases where the experiments were made, before formulating any absolute rule on the subject. The height of the top of the chimney, both above the sea level and above the basement of the house, is one fact needful to determine. The force of the wind is another. Thus, a wind of the velocity of ten or twenty miles an hour blowing downward at a measured angle would produce a very different effect on the draught of a chimney 40 feet high from that which it would have on the draught of a chimney 100 feet high. If our recently published table on wind pressure (*ante*, p. 200) be referred to, it will be seen how important are these data for the solution of the problem.

Again, the maximum up-draught, we are told, is not with a direction of wind vertically upward, but with one making an angle of about 30° with the vertical. This is a result which it is without our experience either to confirm or to question. But it is clear that the cases must be extremely rare, if ever they occur, in which the top of a chimney would be exposed to a wind blowing upward at a more acute angle than 30°. The determination of the same angle as the limit of downward and of upward efficiency is as elegant as it is unexpected.

A yet more practical part of the subject is the remark of Lord Rayleigh, that a "chimney with a T-piece at the top never produced an unfavorable effect on the up-draught, and only in one case failed to produce a favorable one." Professor De Chaumont thought vertical ends would increase resistance to the up-draught. So do ninety-nine people out of a hundred. We have no hesitation in saying that Lord Rayleigh is right, and that general opinion is wrong, provided, that is to say, that the protection of the chimney-top be rightly designed. And we say this absolutely and unhesitatingly, because our judgment is based on the two independent and concurrent sources of evidence afforded by observation and by direct experiment. In Southern Italy chimneys, no doubt, are comparatively few, but they exist in many buildings, and no Italian architect would dream of leaving a vertical flue or pipe open at the top to receive the tremendous downpour of rain which occasionally occurs in Italy with almost tropical violence. The aperture of the chimney is always roofed over, the smoke escaping by side apertures. The practice of the master builders of the world is thus in accordance with the theory of the English scientific noble in this respect.

Experience, we have said, confirms the remark. And here, if we seem for a moment to depart from an admirable rule—that of not mentioning in a scientific paper anything that may look like an advertisement—we must explain that such appearance is deceptive. We have to refer to an admirable invention, which was made and sold some forty years ago under the name of Day's Patent Wind-Guard. As to the validity of the patent it is not needful now to inquire, as in any case it must have long since expired. But what we lament is, that, so far as we can discover, this admirable invention has been entirely forgotten. In recent inquiries which we have instituted in order to obtain one of these wind-guards for our own use, we have been unable to discover that they are now made, although figured in some old trade-books. It may, therefore, be of much use to give such particulars as will guide any one in constructing an appliance of the kind.

Let us take, for example, the case of a chimney two bricks and a half, or 22½ inches, square, with a flue of 9 inches square. A frame is to be constructed which would lie upon this hollow square, and allow bricks to be built on it to the height requisite to hold it steady. From this frame the guard itself rises as an octagonal shaft. Four pieces of sheet iron, or of slate, each 9 inches wide and 18 inches high, are fixed on the lower frame, 16 inches apart, so as to form four sides of an octagon, and the other four sides are formed of four similar plates, set at angles of 45° with the former, but so much within them as to allow 1½ inches to 2 inches clearance between the edges. These inner plates will just touch the outer angle of the 9 inch flue. A top of iron or of stone holds the upright plates together, and both top-plate and base-plate may be finished with a simple moulding. Sheet iron is perhaps the best material, but it is obvious that the contrivance may be made also in slate.

As to the perfect security which this guard effects from wind, we can speak not only from the testimony of those who have used the plan, but from careful experiment. With models of the wind-guard, made on the scale of 1 inch to a foot, set on small tubes of proportionate size, representing chimneys, which were fed with smoke from the combustion of paper, we have experimented by means of powerful jets of wind, driven in various lines of force; vertically downward on the top of the guard, horizontally at right angles to either side or angle, or in any other direction. In no case have we found it possible to produce down-draught in the chimney by force of wind. On the contrary, the greater the force the better the draught of the chimney.

The *rationale* of this action may be illustrated by that of a much later invention, now in common use on our railways—the steam injector. Let those of our readers who desire to master the subject, and have no more ready mode of doing so, refer to the diagram and description of this appliance which is given by Sir F. J. Bramwell, on p. 335 of a work recently published by Messrs. Longmans, under the title "Railways and Locomotives." It will there be seen that "steam, escaping at high velocity through a circular orifice, induces a current in a body of water in connection with that orifice, and carries it forward at the less velocity corresponding to the increased weights of the combined stream of water and steam, but still at a high velocity." This stream passes into an expanding channel, where its velocity is further reduced, and so into the boiler, which is thus fed with water.

In the case of the wind-guard, the wind striking on the outer plate causes a current of proportional velocity between the edges of the outer and inner plates, and thus creates an induced current, which comes in aid of the draught of the chimney. The difficulty to be overcome is far less than in the case of the two fluids of unequal specific gravity. But the effect is so much the more powerful. We are familiar with the contrivance mentioned by Professor De Chaumont, which has been used for the protection of lamps from the dash and spray of the sea, as we believe, with admirable results. But it is a much more complicated, and therefore more costly contrivance than the very simple one which we have endeavored to rescue from oblivion. And we think that it is purely protective in its action, while the construction that we describe is not only protective, but absolutely aids the up-draught; and moreover, the cone is more likely to become choked with soot. The brush of the sweep can easily ascend into the interior of the wind-guard, in case of any soot lodging there.

We have little doubt that any enterprising manufacturer who will discover one of these old wind-guards (they were made and sold somewhere in Pimlico, in 1842), make some to pattern, and introduce them to the trade, will at the same time do a good stroke of business and confer a very great benefit both on the architect who has to build in exposed and gusty situations, and on many a householder who now knows too well, and that to his cost, when the wind is in east—or in that quarter, wherever it may be, that is hostile to the good behavior of one or more of his chimneys.

We are not acquainted with any mathematical formulæ intended for the guidance of the architect as to the height or draught of chimneys. It may, therefore, be of some service to provide a simple table for the use of the architect and of the builder, stating, in the first instance, the principles on which it is calculated.

The only cause of that upward movement which we call the draught of a chimney is the difference between the weight of the column of air and vapor in the shaft, and that of a column of equal height of the exterior atmosphere. This difference of weight must be enough to overcome the friction within the chimney shaft, and any resistance to free discharge at the top. It is obvious that the ascending volume consists of matter which, at equal temperatures, is heavier than atmospheric air, as it contains soot, or finely comminuted carbon; carbonic acid, sulphur, and other matters naturally heavier than air. Calling attention to the existence of these two sources of retardation, viz., friction and the loading of the column, it will be safe to neglect them in tabulation, as it is very difficult to determine the absolute heat of the ascending column, and a few degrees, more or less, will amount to quite as much as the elements thus neglected. With this explanation, the formula that regulates draught may be thus stated:

$$D=(a\ t.—a\ t')h,$$

where D=the draught, $a\ t.$ the weight of a cubic foot of atmospheric air at the external temperature, and $a\ t'$ the weight of a cubic foot of atmospheric air at the mean temperature within the shaft, and h the height of the chimney. It is obvious from a glance at this formula of how much importance the addition of a very few feet to the height of a chimney must be.

To increase the draught, we must increase either h, the height of the chimney, or t', the temperature of its contents. This explains at once the efficacy of the best appliances for increasing draught—such as the bi-valvular registers in this country, and the iron blind that is drawn down within the chimney aperture in the wood-burning fireplaces of France and of Belgium. The larger the aperture below, the greater the quantity of cool air that enters the chimney, the lower is t', and the less the draught. The more the air that enters below is compelled to pass through in close proximity with the burning fuel, the higher does t' become, and the more powerful the draught. This is the simple key to the whole theory and practice of draught produced by heat. Of course, in different conditions of the barometric column equal amounts of heat will have somewhat different effects. Hence, we can see in a moment why our fires should "draw" so much better in clear cold weather than when the air is warm, or loaded with damp. The weight of a cubic foot of air at 32° Fahr. is 0·080728 lb. avoirdupois.

If the top of a chimney-flue were closed by a flap or hinged valve (the weight of which we take as counterbalanced), the effect of the draught, or rather of the downward pressure of the external atmosphere which causes the upward draught, would be to lift the valve in proportion to the force of the current. If, at the same time, a strong wind be blowing over the top of the chimney (in the direction of the hinged end of the flap), its effect would be to force down and close the valve. The stronger current of the two will obtain the mastery to the degree of its excess of pressure. This is also the effect, it will be seen, of cross current where there is no valve, but where the two currents more or less interfere with the movement of one another in the way shown by the action of the valve.

It is possible wholly to eliminate the ill effects of this cross current, and even to utilize it in aid of draught, by any contrivance that causes the external blast to produce an induced current from within the chimney; and this, it is easy to see, is the effect of the wind-guard.

In calculating the following table, we purposely use round and approximate figures, as quite sufficiently accurate for practical purposes, and as more readily intelligible to many readers than more complicated mathematical expressions. We have also used the pressures proportionate to velocity as allowed by Smeaton. Now, assuming, for convenience of calculation, an increase of temperature of 108° Fahr. (that is, from 62° to 170°), as imparted by a fire to the ascending column of air that passes over it up the chimney, we shall have an upward pressure of a fraction over 0·04 lb. for every foot of ascent in the shaft. This is represented in the following table of comparative heights of chimney, pressures, and velocities of current, calculated for that rise of temperature:

TABLE FOR CALCULATION OF CHIMNEY DRAUGHT.

Height of Chimney in feet.	Pressure due to 116° Fah. in pounds per foot.	Velocity of draught in miles per hour.
30	1·2	16
40	1·6	18
50	2·0	20
60	2·4	22
70	2·8	24
80	3·2	26

In rising from 15 feet to 50 feet, there is an increase in the local velocity of the same wind from 60 to 70·8 miles per hour. In raising a chimney from 15 feet to 50 feet, we should obtain an increase of draught pressure of from 0·6 lb. to 2·0 lb. per foot, as against an increase of wind pressure, in a great storm, of from 20 lb. to 27 lb. per foot. The gain is more than threefold; the loss, less than 33 per cent. We mention this, not as a difficulty, but to show that proper consideration must be given to the whole subject.

It is, of course, apparent that if we have an ordinary fireplace, with a chimney 50 feet high, and with that proportion of fuel and of draught which gives a current of twenty miles an hour to the ascending column of smoke, the aperture at the top of the chimney would be closed by a cross-current blowing at the rate of seventy miles an hour, almost as efficiently as by a valve weighted to 27 lb. per foot. The fire, in fact, would have to be extinguished. But the pressure of 27 lb. per foot, or 0·19 lb. per inch, is very trifling in comparison to the pressure of steam in a boiler; and as the action of the injector by induced current is an ascertained fact, it is plain that it is within the province of the engineer to make the hurricane, blow it ever so wildly, produce an induced current through a chimney, so that the draught shall in no way be reversed by storms. As to that, there can be no doubt, although this may be the first time that the statement has been definitely made. We have given what our own experience has led us to believe to be a simple and effective means of producing this induced current. If any of our readers can recommend a better plan, we shall be happy to make it known.—*The Builder.*

THE TREATMENT OF READY SENSITIZED PHOTOGRAPH PAPER.

As a rule, ready sensitized paper requires to be only slightly overprinted. The prints should be trimmed before washing—not only to economize the toning bath, but because the clean edges are much less liable to tear. Having the prints ready for washing, prepare your toning bath.

Stock Solutions.

No. 1.

Chloride of gold..... 15 grains.
Water..... 15 ounces.

No. 2.

Saturated solution of borax in water.

For each sheet of paper place in a jug one ounce of the gold solution, half an ounce of the borax solution, and fifteen ounces of water; stir well, and allow to stand until the prints are ready for toning.

Washing.—Put in a washing tray or basin about a pint and a half of water to each sheet of paper. Immerse the prints one by one, face downward, and allow them to remain for ten minutes, moving them about from time to time, and being particularly careful to keep them face downward, to prevent as much as possible the deposit of the chloride of silver on the surface. If this deposit be allowed to take place, the effect will be apparent in the finished print, and will not add to its beauty. The action of the toning bath will be exercised on the particles of chloride of silver instead of on the reduced silver of the print beneath, and, being soluble in the fixing bath, will leave minute untoned spots, giving a patchy, unsightly appearance.

From this first washing water remove the prints to another vessel containing a similar quantity of water, in which has been dissolved a pinch of table salt to the pint. The same treatment should be adhered to as before—that is, keeping the prints face downward and moving them about, so that they may be equally acted upon. At the expiration of ten minutes they should be again placed in plain water, and, after a slight rinsing to dilute the salt contained in them, they are ready for the toning bath. It will now be observed that the prints will have considerably changed in appearance, being of a bright orange color, and appearing much lighter and less deeply printed than before washing. It may occur also that this salt solution will retain its clearness and not become milky. This is not necessarily because all the free silver has been washed out in the previous washing, but because the small quantity of chloride of silver formed is dissolved, it being slightly soluble in a solution of chloride of sodium.

Toning.—Having placed the toning solution in a convenient receptacle, introduce the prints singly, taking care that each be thoroughly immersed in the solution. No more prints should be toned at one time than can be turned without risk of injury. They should be kept face downward until they have nearly reached the desired tone, when they may be turned face upward, in order to judge more accurately of their progress. Care should be taken to keep both the prints and the liquid in motion. As they reach the tone it is required the finished prints should possess, remove them to a vessel containing a solution of table salt, there to remain until the whole are toned and ready for fixing. The salt solution used for the second washing may be used again for this purpose.

The toning bath should not be of a higher temperature than 65° Fah. in winter or the temperature of the atmosphere in summer, or mealiness is likely to result. Everything working well, the toning will take about fifteen minutes.

Fixing.—As the permanency of the prints depends to a very great extent indeed upon the fixing bath—the method

of making it and the method of using it—it is certainly worth while to take every possible precaution during this stage of the proceedings. It is unfortunate that the consequences of neglect can only be detected in the future. The actual reason why some prints fade in a very few years, or even months, while others retain their pristine beauty for many years, still remains an apparently inscrutable mystery, but that the cause is in some way connected with their treatment after toning has not been disputed

Sufficient of a solution (according to the number of prints to be treated) of hyposulphite of soda four ounces, to water one pint, made slightly alkaline with ordinary washing soda, should be made. If there are not many prints, they may be all fixed at one operation, but on no account must the same solution be made to serve for more than one batch of prints. The solution should be made before washing the prints; and, as hyposulphite of soda produces a considerable lowering of the temperature during solution, it should be made with warm water, and at the time of using, the temperature may be a few degrees higher than that of the atmosphere. It should not be exposed at any time during or after solution to actinic light. The prints should be immersed for fifteen minutes, and during that time should be continually turned over one by one to insure perfect solution of the soluble silver salts.

Of the method of washing it is not proposed to treat here: however, whatever way be adopted, it is well to bear in mind that a prolonged soaking not only does not improve the appearance of the finished prints, but is not nearly so efficacious as a thorough washing for two or three hours in running water or in several changes of water. The whole of the operations should be conducted by non-actinic light, except the toning, when a sufficient amount of weak daylight may be used to enable the change of color to be correctly judged. The same vessels should be kept for toning and fixing respectively, and they should be used for no other purpose. Scrupulous care should be taken that no trace of hyposulphite of soda should reach the prints before they are fixed.

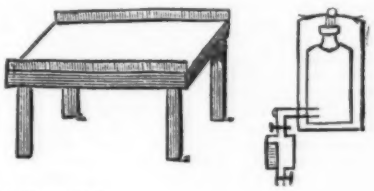
Slight modifications may, of course, be made to suit individual requirements, but it is important that the washing of each batch of prints should be carried out in as nearly the same manner as possible, or difficulties will be encountered in the subsequent operation of toning. An imperfectly washed print will change color more quickly in the toning bath, but will lose tone in the fixing, and will, therefore, require to be overtoned. It is liable also to tone irregularly, some parts of the print turning blue before other parts are more than half toned.

Whatever variations are made, the main principles should be carefully adhered to, and, unless uniformity in treatment is practiced, uniformity in results cannot be expected.—*Alexander Mackie, in Br. Jour. of Photo.*

ON COATING GELATINE PLATES.

I WISH to direct the attention of all who, like myself, regard hand-coating as a messy business to several suggestions which, if properly carried out, would render the operation more certain and less disagreeable. Mr. J. Browning, of Exeter, includes, in the drawings with which he favored me, a sketch of a simple and efficient arrangement for keeping the emulsion at a fairly uniform temperature during the time occupied in coating and delivering the exact quantity required for each plate.

It consists of a tin vessel in which the emulsion bottle is placed and kept surrounded with warm water. The bottle is tubulated—that is, has a second neck on the side close to



the bottom. Such bottles are kept in stock by dealers in chemical apparatus, and may be got of various sizes at a small cost. A hole is made in the tin at a spot that will correspond with the neck of the bottle, and both are fitted with perforated corks through which passes, water tight, the delivery tube. This may be described as a pear shaped pipette, but of thicker glass, and with a stem of larger bore than pipettes are generally made. The stem is bent to a right angle a few inches over the bulb, and the straight part above the bend must be long enough to pass through the two perforated corks and into the bottle. Two taps or stopcocks are inserted one above and one below the bulb, but the latter must be of sufficient size to hold enough emulsion to coat the largest size of plate likely to be coated, and graduated in the various quantities required for smaller sizes. This article will, of course, require to be specially made; but, glass-working being now much less expensive than it used to be, it need not cost more than a few shillings.

As the temperature of the emulsion will be kept practically uniform, the exact quantity can be accurately measured and easily delivered to each plate, and all that remains to be done is to rapidly and evenly spread it over the surface.

In the absence of anything better, I think the following plan will be found to answer tolerably well—certainly better than anything I have yet come across: To a block of wood the exact size of the plate to be coated, is cemented, or otherwise fixed to each of its two longest sides, a strip of glass, the edge of which projects above the surface to the extent of the desired thickness of the film. The block is accurately leveled, the plate laid on its surface between the two strips of glass, the proper quantity of emulsion measured by the opening of one of the taps, and delivered by the opening of the other, and then one or two sweeps of a glass rod resting on the edges of the glass slips complete the operation most satisfactorily.

It need hardly be added that the emulsion tap should stand immediately over the plate; and, as the fall should be slight to prevent formation of air-bubbles, it ought to be arranged so that, as soon as the emulsion is delivered it can be turned round so as to be out of the way of the glass rod.

In this way the plates are operated on one by one; but, by a slight modification of the arrangement, I think it possible to make it almost automatic, so that a succession of plates, each pushing its neighbor under a regulated stream of emulsion and a fixed rod or scraper, could be coated and spread very rapidly. At all events, I throw out the hint for the consideration of those who want to do much work in little time.

The idea is simply to elongate the leveling block to any convenient extent, make the scraper a fixture in a suitable position, and regulate the flow of the emulsion, and the rate at which the plates are made to travel so as to make the actions reciprocal.—*John Nicol, Ph.D., in Brit. Jour. Photo.*

NEW SUNSHINE RECORDER.

THIS improved apparatus is constructed upon a design of Mr. Whipple, the director of the Kew Observatory, and Mr. Casella, the well-known optician of Holborn Bars. The instrument, as our readers will see from the drawing, is an adaptation of the glass sphere which Mr. J. F. Campbell was the first to suggest as a ready means of recording the hours and minutes of sunshine. The sphere acts as a convex lens or burning glass, and is thus made to produce a charred line along a printed sheet or diagram that is placed suitably in the focus of the rays. The diagram is divided into spaces representing the hours of the day, and if at sunset it is found that a charred line exists throughout all these spaces, there is proof at hand that the sun has been shining all day. In the same way, if the charred line only appears at certain intervals on the printed sheet, then we know that during certain times of the day only has the sun shone, the actual periods of dull and bright weather being at once shown by the diagram.

About ninety per cent. of sunshine may be in this way recorded, for very feeble sunlight fails to exert any action; but we suggested in our former article that if a more sensitive recording material were necessary, this might probably be produced by treatment of the paper to be charred with slightly sensitive chloride of silver or other similar medium.

There are, however, some slight defects in the Campbell recorder, which have led to the design of the present improved instrument, one of the shortcomings being the fact that it is necessary to construct the instrument especially for the latitude of the spot where it is to be used. It cannot be

SUNSHINE RECORDER.

transferred from one place to another. The Whipple-Casella instrument, on the other hand, is universal; that is to say, it may be set to work in any part of the world on adjusting the polar axis, B C, of the glass sphere, A, to the height of the pole at the place of observation. When this—the latitude—is known, the adjustment of the instrument may be performed at once by means of a graduated circle, D, provided for the purpose.

Another defect of the Campbell instrument is the necessity of having the diagrams or cards cut to different curvations to fit round the sphere at different seasons of the year, as also the necessity of shifting them from day to day. The Whipple-Casella supporter is provided with several movable card holders, K, all adapted to receive strips of card cut straight, and of uniform width, so that they are perfectly interchangeable one with another, and the same kind may be used all the year round.

The card holders are held in their place by a clip, E, so that when it is necessary to change the paper, one holder is slipped out and another in, an operation occupying but a second or two, leaving the observer at liberty to remove the cards from the holder at any time during the day when convenient, and allowing of his drying them before the fire, if wet, before withdrawing them from the grooves, thereby avoiding the risk of tearing or destroying them in the operation.

In order to assist the observer in placing his card in the proper position for receiving the sun's image, a graduated scale, F, is provided, engraved with divisions indicating the sun's place any day of the year. If, then, the pointer be set to the correct date, and the clamp, G, be screwed fast, the card will be in its correct place.

Owing to the smaller diameter of the circle described by the sun's image round the glass sphere at the solstices than at the equinoxes, it is found necessary to have card holders to two different diameters, the larger ones to be used during the months of May, June, July, and August, while the smaller ones are employed the remainder of the year.

The relative scale value of the trace produced by the passage of the sun's image over the paper also varies to a corresponding extent; but by using a tapering glass scale the cards can be tabulated without any inconvenience.

The most convenient cards are cut from Bristol board, tinted with Prussian blue, and divided into slips thirteen inches long by three-quarter inches wide. We cannot help thinking that firms which do much printing would find in the sunshine recorder an excellent check upon work done.—*Photographic News.*

PRIOR INVENTION OF THE RHEOLYZER.—A NOTE FROM PROFESSOR FLEISCHL.

To the Editor of the Scientific American Supplement:

In the issue of the SCIENTIFIC AMERICAN SUPPLEMENT of October 14, page 5643, you gave an item about "Wartmann's Rheolyzer." Now I beg to say that I constructed and described that apparatus long ago ("Sitzungsberichte der Wiener Kais. Akademie der Wissenschaften," July, 1877). A few months after the publication of that paper the well known "Beiblätter zu Wiedemann's Annalen" gave a fair record of it. Though it might be expected of every physicist that he may be acquainted with the contents of both of these periodicals, I do not doubt in the least that Professor Wartmann had no knowledge of my having previously invented the apparatus (described by me as "Rheonam") before him. You will oblige me and your readers, and most likely also Professor Wartmann, by printing these lines in your paper, and so correcting the above mentioned mistake.

Yours very truly,

PROF. ERNST VON FLEISCHL,
Vienna University.

Vienna, Währingerstrasse, No. 11, October 30, 1882.

STATIC ELECTRICITY INTO VOLTAIC CURRENTS.

A VOLTAIC current, sent through a conductor, causes, by induction, it is well known, a contrary current in a closed parallel circuit that is near. On removal of the inducing current, there is generated in the same circuit a current of direction opposite to that of the first. If the resistance of the induced circuit be considerable, the two currents thus generated have the character of electricity of tension, and may reproduce the effects of ordinary electrical machines. This is the theory of the Ruhmkorff coil.

Such being the case, it was natural to inquire if the system were not reversible; if, in other words, on sending through the fine wire of a coil the discharge of an ordinary electric machine, there would not be generated in the thick wire an induced current of very small tension, and similar to voltaic currents.

It was in 1875 that Bichat made his first experiments in this relation. He was able, with a Holtz machine and a Ruhmkorff coil, to decompose water and to deflect permanently the needles of a galvanometer. He stopped there, either failing to see all the importance of his discovery, or drawn to other work which seemed more pressing. Professor Govi, an Italian, has been engaged for some time with the subject. When he heard of the discovery of the French savant, he suspended his investigation; but, perceiving that Bichat had "interred" the question, he resumed operations, and has obtained several highly interesting results (published in the *Revista Cientifico-Industriale*).

For the experiment just described to succeed, the electric discharges must be pretty strong. Without this condition (which is easily realized with condensers), the effects of the induced current are too weak to be easily observed. Another condition to be attended to is not to allow much interval between the inducing currents, destroying the quasi-continuity (a point of similarity to the voltaic current)

This induced current has, indeed, a character by which it is easily distinguished. Instead of being really one and continuous, it is double and discontinuous. When the spark passes, an induced current is generated in one direction, and immediately after passage of the spark, there is another current of opposite direction. But the rapidity of the electric discharge is such that, practically, these two currents seem to make but one. Another cause of discontinuity is the discontinuity of the inductive sparks themselves. Apart from these features, the generated current behaves quite like the currents produced by batteries with liquids.

Its tension is very small, and then it does not give a spark even with the least interruption of the circuit. On passing the current through the acidulated water of a voltameter, decomposition occurs, and under each test tube a certain quantity of gas collects. As the current is continually reversed, the gas is a mixture of oxygen and hydrogen, the proportions of which vary in each experiment. By regulating suitably the resistance in the induced circuit, a means may be found (it is thought) of eliminating one of these two currents, and so of separating the gases one from the other.

On putting a galvanometer in the circuit, the needle is not sensibly deflected, so long as the circuit does not present a special resistance; but if an interrupter be introduced (a Froment vibrating reed, *e. g.*), the needle is suddenly and permanently deflected, and this deflection is so considerable as to inspire the hope of being able to utilize the induced current.

If one of the rheophores be connected with a file, and the other drawn over the rough surface of the file, one obtains a track of reddish light like that produced on repeating the experiment with a voltaic battery. This phenomenon is not that of the spark: it is due to particles of iron and carbon, which, under action of the current, are detached from the line, fused or volatilized, and forming a sort of bridge between the asperities over which the reophore is drawn.

If the two reophores, each terminated by a very fine point of carbon, prepared for the voltaic arc, be brought into contact and then separated, one immediately sees a jet of electric light, similar to that furnished by the Gramme machines and batteries. On repeating these experiments with a conducting wire and a bath of mercury, a luminous arc is obtained, due to incandescence of mercury vapors; this arc is less brilliant, but more durable.

The induced currents circulating round a cylinder of soft iron produce in it rapid magnetizations in two opposite senses, as may be demonstrated, either by the magnetic spectra obtained with iron-filings, or by the vibrations of a very mobile and very light slip.

Lastly—and this experiment is the most curious of all—the induced current, generated in a Ruhmkorff coil by the electric discharges, may be sent into a second coil like a battery current, and will produce in that long sparks, with which all the phenomena of the Ruhmkorff coil may be repeated.

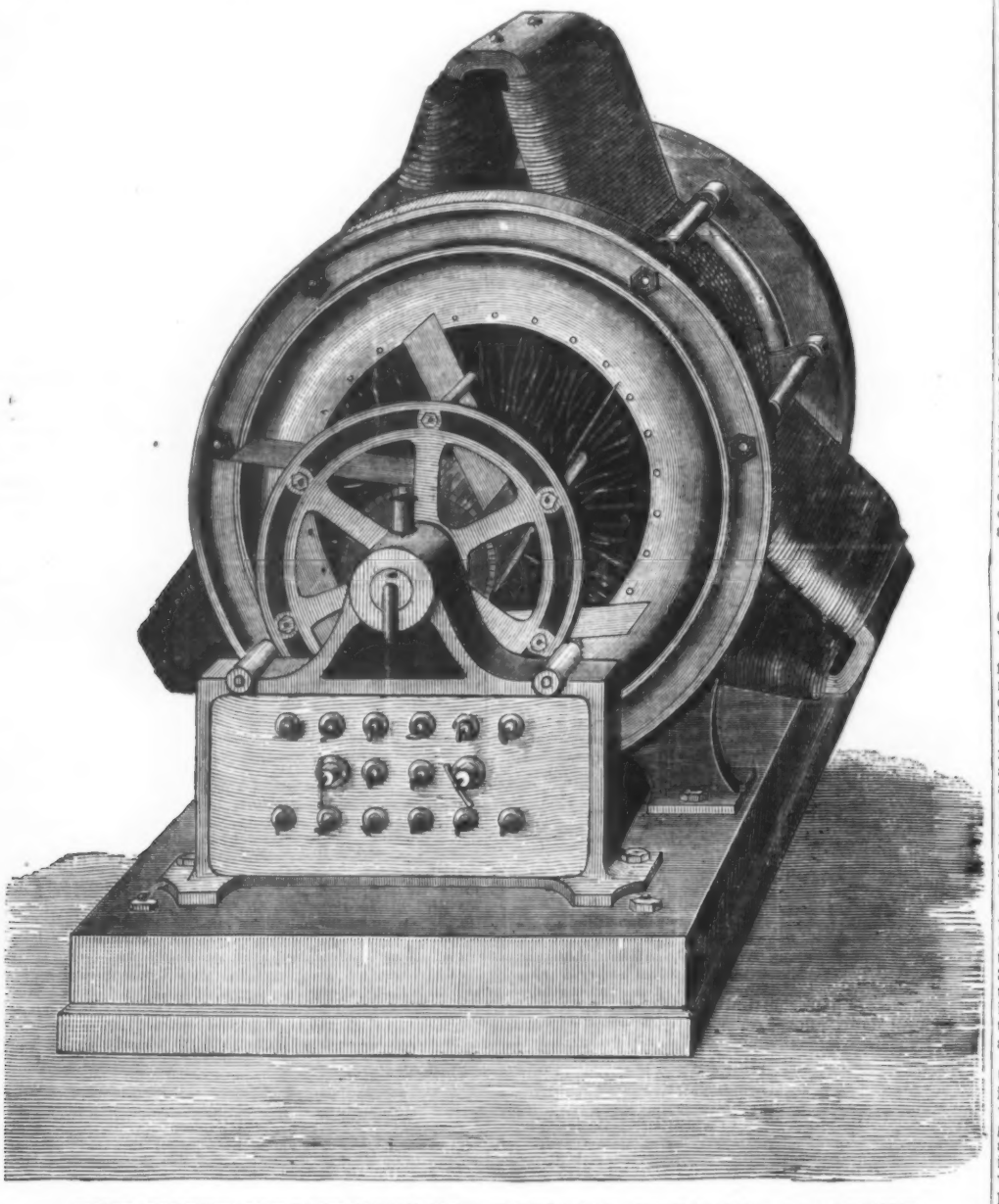
These, then, are the chief results obtained in transformation of static electricity into dynamic currents. What may the future of this discovery be? If, with the small Holtz machine, which served as exciter of the current in these experiments, Prof. Govi was enabled to decompose water, redden a bad conductor, and produce the voltaic arc, we need not despair (says M. Battandier in *Les Mondes*) of obtaining powerful currents with improved apparatus, and that with a less expenditure of force. "We may even, perhaps, by multiplying or better insulating the discharges of atmospheric electricity, become master of this fluid, so capricious and menacing, and turn it to domestic use."

THE ELPHINSTONE-VINCENT DYNAMO ELECTRIC MACHINE.

SEVERAL of these dynamo electric machines have just been constructed, and we understand, says the *Electrical Review*, that their efficiency is very high, but in the absence of any data we can only make this statement with reserve. The machine here illustrated weighs complete about 26 or 27 cwt., and is constructed for working 400 incandescence lamps. It will be seen that three V shaped electro-magnets surround the armature, there being therefore six poles of N and S alternately. Inside the armature is an iron spindle carrying six internal electro-magnets of similar polarity to those above.

The armature is not coiled with wire, as is usually the case, but flat hollow parallelograms of double wire are constructed and laid on the outside surface of the armature drum, which is formed of a kind of *papier-mache*. These parallelograms of wire are laid all around the drum, overlapping each other, and they are firmly bound down with string or any suitable binding.

The ends of the wire coils are connected up with a comumtator in all respects similar to that employed in the Gramme machines. There are six brushes employed, which can all be easily adjusted to the best point of the commutator. The ends of the electro-magnets are brought to the terminals



THE ELPHINSTONE-VINCENT DYNAMO ELECTRIC MACHINE.

seen on the face of the machine—the inside ones through the spindle—so that any desired coupling may be made. There are several points of novelty in this machine which, however, we shall fully deal with shortly.

The arrangement of the amature drum, its coils, and the electro-magnets forms the chief feature in the machine, for it is by means of this that the external and internal poles of the electro-magnets are brought very near together, thus forming a magnetic field of great intensity, through which the coils of wire on the surface of the armature drum pass.

ON MAGNETO-ELECTRIC AND DYNAMO-ELECTRIC MACHINES.

By J. ANGELO FAHIE, Inst. C. E., Ireland.

Faraday's Discovery.—In the year 1831, the illustrious Faraday made the important discovery, that by moving a coil of wire in the presence of a magnet a current of electricity was generated in the coil, or, *vice versa*, by moving the magnet and holding the coil stationary a like result was obtained; thus a current of electricity was obtained, either by moving a wire in the presence of a stationary magnet, or by moving a magnet in the presence of a stationary wire. The intensity of the current so obtained depended (1) on the strength of the magnetism present, and (2) on the velocity with which the coil was moved through the magnetic field. Upon this simple phenomenon is based the whole of the recent important development in electrical science, and to Faraday we owe the credit of having laid the foundation of the many useful inventions by means of which electric lighting, as well as the transmission of power, and the propulsion of tramcars by electricity, has been made practicable to-day.

Now, with the knowledge that it was possible to generate electric currents in the manner shown by Faraday, it only remained to devise some mechanical means whereby the different elements which producedt be temporary or momentary currents could be combined, so as to collect them, and cause them to flow in rapid succession the one after the other without interruption.

Pixii's Machine—The first attempt to devise an electrical machine was made by Pixii, who, in the year following the discovery of Faraday, constructed a machine consisting of a permanent magnet, which he caused to revolve in front of the iron cores of a pair of bobbins forming an electro-magnet. We find this invention was considerably improved upon by other workers in the field of science, especially by—

Saxton and Clarke, both of whom succeeded in producing very useful electric generators, in which the mechanical arrangement is the reverse of that in Pixii's—*i.e.*, the magnets are fixed and the coils of wire movable; and it is on this plan all the subsequent machines have been constructed, as affording better results than where the coils are stationary and the magnets movable. The little magneto machines still sold by opticians are constructed on this principle.

Following the inventions of Saxton and Clarke are those of the *Holmes* type, better known as the Alliance machines, which, however, are now rarely used in this country, and we shall not, therefore, dwell upon them, but hasten on to the important invention of *Dr. C. W. Siemens*, who in the early days of magneto electricity accomplished a great deal toward reducing to practical form the principle of generating electricity by mechanical force. Dr. Siemens' improvement in 1857 consisted essentially in a new form of armature, the construction of which must be familiar to everybody, as, owing to its simplicity and cheapness, it is still used for many purposes, especially for electro-plating and laboratory work. It is composed of a cylinder of iron in which deep longitudinal grooves are cut, resembling in section the letter H. In these grooves is wound lengthwise a simple coil of wire, the two ends of which, being joined to a split tube of copper on the axle, form a commutator from which the current is taken off by brushes or springs rubbing against it. By this longitudinal armature the advantage was gained of cutting the greatest number of lines of force when rotated between the poles of a series of adjacent magnets. The modern armature used in the Siemens machine is somewhat more difficult and complicated in construction, and will be described further on.

A few years subsequent to the invention of Siemens, *Wilde*, of Manchester, hit upon an important improvement by constructing a machine consisting practically of two Siemens machines combined—a large and a small one; and in the large one he dispensed with the permanent magnets and substituted electro-magnets, which he caused to be excited by the current produced by the smaller one. By this arrangement considerably more powerful currents were obtained than by any of the machines previously constructed.

Siemens' and Wheatstone's Discovery.[*]—Next in the order of remarkable electrical phenomena comes the important discovery made simultaneously, but independently, by Dr. Siemens and Sir C. Wheatstone—a discovery which marks the transition of the *magneto*-electric machine to that type most in practice at present—the *dynamo* machine, called for convenience the dynamo. What Dr. Siemens and Sir C. Wheatstone discovered was this: That a current of electricity could be generated in the coils on the armature by the feeble residual magnetism in the iron cores of the electro-magnets, and that by passing this feeble current round the magnets, their magnetism would be strengthened, which in turn would produce a stronger current in the armature, and this current would again react on the magnets rendering them more powerful, this action going on until the limit of saturation is attained; for it must be understood that this mutual accumulation cannot go on indefinitely, the magnetism in the iron cores cannot be intensified beyond a certain point, and this point depends on and is controlled by the scientific conditions on which the machine is constructed.

Among the several machines constructed on the principle discovered by Siemens and Wheatstone, the most famous are those of Gramme, Siemens, Edison, Brush, Burgin, and Gulcher. They differ chiefly in the construction of the armature and the arrangement of the electro-magnets. The electromotive force generated in each of them is proportional to the number of turns of wire in the rotating armature, and, within certain limits, to its speed of revolution. Currents of small electromotive force, but of considerable quantity, are obtained by making up the armature of only a few turns of stout wire, or bars of copper (as in the Edison machine), offering only a slight internal resistance. Currents of high electromotive force are produced by forming the armature of many coils of very fine wire and driving it very fast.

The term *electromotive force* may be compared to the pressure of water, being the electric condition necessary to overcome the external resistance of the circuit, just as a given pressure of water is necessary to overcome the resistance offered to its flow—for instance, to move the plunger of a hydraulic press; and as a given quantity of water under pressure is required to keep the plunger moving, so a given quantity of electricity under a given electromotive force is required to keep the lamp burning or the electro-motor moving, as the case may be. The unit of electromotive force is termed a *volt*, which is approximately equal to the force of a Daniell cell; the unit of resistance is an *ohm*, which is the resistance a current experiences in passing through a copper wire 10 feet long by 10 millimeters in diameter; and the unit of current, the *ampère*, which is one volt passing through one ohm in one second of time, or the volt divided by the ohm, and is represented by the equation:

$$C = \frac{E}{R};$$

C being current, or ampère; E being electromotive force, or volt; R being resistance, or ohm.

Siemens' Modern Machine.—In a suitable frame, powerful flat electro-magnets are fixed, the upper pair having their north poles facing one another and united by arched pieces of iron, and the under pair having their south poles similarly united. In the space thus formed between the upper and lower magnets the armature rotates, consisting of a cylinder round which are wound longitudinally a number of coils in a peculiar manner, and crossing over each other at all angles at both ends of the cylinder, each end of each coil being connected with segments of copper mounted on the axis and forming the commutator. It will be observed that in this machine the two poles of the field magnets act simultaneously on each coil, and the double action operating on opposite sides of the coil, where the current has a contrary direction, the resultant effect is the same.

Edison's Machine.—The next important development which we shall notice in the Siemens type of generators is that of Edison, who has succeeded in applying to practice the largest dynamo yet constructed. Its total weight is about 30 tons (including the engine, which is coupled on direct to the armature shaft), and it is capable of 900 ampères. An idea of its colossal size may be formed by comparing it with the largest Gramme made which weighs only about one ton, and yields a current of only 90 amperes.

The Edison armature resembles in form that of Siemens, but differs essentially in the method of its construction. The iron core is built up of a number of sheet-iron disks, or washers, insulated from each other and bolted firmly together by bolts passing through them in a line parallel to the axis of the core. This method gives the advantage of a solid iron core, and prevents the circulation of local currents which are usually set up in solid cores, causing a loss of power. Instead of the usual insulated wire, the coils are composed of heavy copper bars or prisms, longitudinally arranged, and insulated from each other and from the iron core underneath, and these bars are connected at each end by copper disks of the same diameter as those forming the core. This construction affords very favorable results, and the resistance of the armature is reduced to a minimum, while, owing to the annular space between the bars and the core, a free circulation of air is maintained, thereby reducing the tendency to heat and increasing the capacity of the machine. Edison uses long cylindrical masses of metal for his field magnets, wound with only a few convolutions of wire; and by this arrangement he claims to secure a more powerful magnetic field than by using the same weight of metal of shorter length.

The Paccinotti Type.—In the year 1860, Dr. Paccinotti suggested the use of an iron ring wound round with insulated wire, which he caused to rotate between the poles of permanent steel magnets. The object of Paccinotti was, however, rather to produce an electro-motor engine than a machine for generating electric currents; and the advantages of the ring armature remained therefore unrecognized until it found its first practical application in the invention of M. Gramme, of Paris, as introduced and described before the French Academy of Sciences in 1871.

The Gramme Machine is generally considered the simplest form of apparatus for generating electricity by mechanical means. At any rate, its action is easily understood. Around the soft iron ring, which forms the core of its armature, a

* Abstract of paper read before the Inst. C. E., Ireland.

* Mr. Fahie, like many others, apparently ignores the claims of Mr. S. A. Varley conjointly with those of Wheatstone and Siemens in regard to the discovery of the reaction principle.—EDS. ELEC. REV.

series of independent bobbins, or coils, are wound, the ends of which are connected to copper plates in such a way as to constitute an endless coil wound in one direction around the ring. The plates are insulated from each other, and so arranged as to form a commutator. This ring is caused to rotate between two powerful electro-magnets, each provided with polar extensions overlapping about two-thirds of the outer periphery of the ring. The magnets are excited by the currents generated in the coils, and the currents flowing from the machine are caught up by brushes or combs which press on the commutator.

The Gramme machine is very popular, and is extensively used both in England and on the Continent.

The Brush Machine.—Closely resembling the Gramme in its general outline appearance, but differing materially in construction and action, is that known as the Brush dynamo, which has recently come into extensive use in the United States and England. For currents of high electromotive force the Brush machine is considered a good one. Its armature, though consisting of a ring like that of Gramme's, is, however, differently "built up." At intervals around the ring a number of transverse grooves are formed, in which are wound the coils or bobbins, all in the same direction; and instead of forming a continuous circuit, as in the Gramme, each diametrically opposite pair of coils are joined to each other by one end of each coil, while the other ends of the pair (*i. e.*, the ends conveying the current) are connected to the commutator in such a manner that a portion of the current flows to the external circuit through one pair of brushes, while another portion of the current is conveyed round the electro-magnets by another pair of brushes. One coil of each pair, in fact, feeds the external circuit, while the opposite coil simultaneously magnetizes the field magnets of the machine itself, thereby strengthening the magnetic field.

The Bürgin Machine, which is considered a useful and practical form of electric generator, is the invention of M. Bürgin, of Switzerland. Its peculiarity lies in the construction of its armature, which, instead of being a single ring as in the Gramme, is made up of several hexagonal frames mounted parallel to each other on the same spindle, and around each of these frames are wound a series of bobbins or coils as in the Gramme ring. By increasing the number of these frames and lengthening the electro-magnets a higher electromotive force can be readily obtained. This armature is considered very simple in construction, easy of repair, and the coils are easily wound, but the manner of joining them up is somewhat complicated and difficult to explain. The free access of air to the exposed surfaces of the frames prevents the coils being unduly heated by the current. This, at first sight, appears to be an advantage possessed both by the Brush and Bürgin machines over the ordinary Gramme, the armature of the latter being so closely and so thickly wound that it is apt to heat with the current when being driven at a high speed. This advantage is, however, questionable when it is remembered that since the ring in the one case is only partially surrounded with coils, in the other case it is completely enveloped. So that for rings of the same size, and driven at the same speed, the Gramme certainly gives out the greatest stream of electricity. The electro-magnets in the Bürgin machine are traversed in their entirety by the induced currants similar to the Siemens and Gramme machines.

The Gülcher Machine.—The last machine of the purely ring type worthy of note here is that known as the Gülcher, which is a modification of Brush's invention, its armature being somewhat similar in principle and form, with the difference that it is provided with fifty-two sections of wire, and rotates between eight field magnets—four on each side. It is also provided with a new feature consisting of troughs or shoes, forming three sides of a square fixed round the ring, so that not only the sides of the revolving bobbins are under magnetic influence but also their peripheries.

De Meritens' Machine is partly descended from the Gramme and Alliance types, and is the only one at present in use which contains permanent steel magnets, all the other electric generators of recent construction containing the more compact and powerful electro-magnets. In construction the De Meritens machine consists of a Gramme ring armature, mounted on a spindle and rotated within a circular frame, on which are placed horizontally a series of powerful steel horseshoe magnets on the principle of the earlier form of the Alliance machines. It gives alternating currents, and its coils can be connected in various ways so as to give tension or quantity currents, as may be required. Great efficiency is claimed for this generator, the adjustment of parts is simple and effective, and it is greatly liked by the British lighthouse authorities.

The use of dynamo machines in the generation of electricity for public illumination has now been sufficiently demonstrated to be both practicable and economical, especially in large areas where considerable light is required, such as railway stations, harbors, and public institutions, not to mention lighthouses, in which the electric light has been used with advantage for a number of years; and again in military operations dynamo machines play an important part in producing the intense light required for illuminating at night a distant point to observed, or lighting up the work of the assailants in sieges. Evidence of their utility in this direction has recently been supplied in connection with the military operations during the late campaign in Egypt.

Next to its importance in the production of the electric light, probably the most useful purpose to which the dynamo has yet been applied is the transmission of power. This property depends on the principle known as the *reversibility* of the dynamo, or, in other words, the transformation of electrical energy into mechanical work, which is simply the converse of what we have been hitherto considering in regard to the means for converting mechanical into electrical energy. In the transmission of power by electricity the current is generated in one machine, from which it is conveyed to another, which may be at any distance, and may be utilized to set machinery of any kind in motion.

The distance over which the electric transmission of power may be carried without serious loss of energy is still a matter of controversy, not having been yet proved by works of any great magnitude. We have it, however, on the authority of Dr. Siemens, as the result of a long series of experiments made by this distinguished electrician, that the total loss resulting from the double process of conversion (*i.e.*, the conversion of mechanical into electrical energy, and secondly the conversion of electrical into mechanical work) is about 20 per cent. To this loss should be added that caused by the resistance of the wires, which depends on their length and sectional area; so that for actual work it is considered safe to assume that the loss sustained over a considerable distance does not exceed 50 per cent., which will not appear very great when compared with the loss sustained in transmitting power by compressed air, water, or other means.

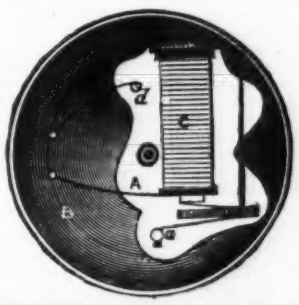
Already tramcars have been caused to run over considerable distances in Berlin and Paris, by electricity transmitted from a stationary generator to one fixed on and coupled up with the axle of the moving vehicle. And in our own country we shall soon, let us hope, have the pleasure of seeing the first really practical attempt of applying successfully and economically the principle involved in the electric transmission of power to a distance. In the electric railway now in course of construction from Portrush to the Giant's Causeway, it is proposed to mount an electro-motor on each car, which will be connected with a stationary dynamo by means of a conductor laid along the rails, the rails themselves forming the return circuit.

It will be a matter of congratulation to the enterprise and scientific genius of Irishmen should this attempt prove successful, it being the first work on a large scale of the kind yet attempted in the United Kingdom.

In conclusion, the author trusted that he had succeeded in imparting some idea of the fundamental principles and construction, as well as of the useful applications of magneto-electric and dynamo-electric machines, through the agency of which it is not too much to hope that we may live to see the vast power stored up in great waterfalls, in the perpetual flow of our rivers, in the rise and fall of our tides, and in the onward rush of mountain streams, utilized and rendered serviceable to the wants and conveniences of man.

IMPROVED ELECTRIC BELL AND BATTERY.

AN improved form of electric bell has been recently invented by M. J. Siegel, of Brünn. As a rule, electric bells are so constructed that the armature is attached to a springing plate, and carries a long projecting arm and knob called the hammer, so as to reach the fixed metal dome called the bell. Such bells are usually fitted by placing the electro-magnets and armature in a wood case, leaving the hammer and bell exposed. By this invention the armature is arranged to work on a pivot or pivots, and the patentee constructs the same, especially for larger bells, in two parts, one of which carries the knob, and receives its action by means of a lever from the other part It will be seen that



COMBINED BATTERY AND BELL.

by this simple arrangement a more correct striking, without vibration, is obtained, and, notwithstanding the use of a shorter hammer, a much louder tone. The electro-magnet, armature, and hammer are generally placed inside the bell, and the whole fixed with its metal case on a plate corresponding to the diameter of the dome. A further important improvement is that, whereas in the usual form of electric bells the action of the hammer must be adjusted by means of a screw, by this invention it is possible to turn more or less the whole apparatus round its axis, and so use the center of gravity of the hammer to regulate the action according to the tone required and the current available. The improved battery consists simply of a zinc rod and a cylinder or block formed of a mixture of carbon and manganese, to which is added a proportion of iron filings, oxide of iron, or oxide of copper by means of moulds and pressure. The solution is as usual of muriate of soda or salammoniac. By this arrangement a powerful and constant current is obtained. The battery acts at once by contact with the solution, and is almost everlasting, as the combination block requires only cleaning, but not renewing, after years of use. After comparative working during twenty-nine days under equal circumstances with one of the best Leclanche batteries, and one of the above construction, the patentee found that the former lost twenty-four per cent. of its strength, and the latter remained almost nominal, as at starting. In the engraving annexed, A is the metallic base with a standard to which the bell is secured; B, the outline of gong; C, Coil, *a* being the contact pillar, and *d* the terminal.

ABAKANOWICZ'S TOTALIZING INTEGRATOR.

THE totalizer adopted by Mr. Vernon Boys is identical with that which Mr. Abdank Abakanowicz presented to the Academy of Sciences of Cracow on the 20th of March, 1880. Like the one that I invented in 1876, and that figured in the Railway Company of the East's experimental car, it has the advantage that it does not cause the totalizing roller to slide. A model designed for the demonstration of this sort of totalizing integrator is shown in the annexed figure. Its essential parts are as follows:

1. A cylinder mounted on points and capable of being moved in a direction parallel with its axis of rotation; the points around which it revolves being for this purpose connected to a frame, MHM'E, which is carried by friction rollers, GG running on rails, RR'.

2. A roller, *r*, applied against the cylinder by a spring which presses continuously against the rod, *ts*, which is movable in a vertical socket, and which terminates in a stirrup, *s*, between whose branches revolves the axle of the roller. The mounting of this latter, as may be seen, resembles that of the steering wheel of a tricycle.

This roller may thus assume two rotating motions—one around its horizontal axle, and the other around its vertical axis, *st*. The latter motion is given it by means of a rod, fV, while it is *rolling* over the cylinder, C; the latter, on another hand, being given an arbitrary motion, whose extent may be measured by means of the needle, H, which is movable along a divided rule, L.

If we designate by

- *a* the angle that the horizontal axis of the roller makes with the axis of the cylinder, C; by
- *dx* the infinitely small space traversed by the frame, MHM'E, in its motion on the rails, RR', during an element of time, *dt*; by
- *dy* the *linear* arc described by the circumference of the cylinder, C, during the same time; and by
- *ds* the *linear* arc described by a point of the circumference of the roller, *r*, in its rotatory motion around its horizontal axis,

it is easy to demonstrate that we have between these four quantities the two relations

$$dx = dx\ tg\ a$$

$$ds = \frac{dx}{\cos a}$$

This latter relation has no interest as regards the question that occupies us, but the first gives

$$y = \int dx\ tg\ a.$$

Consequently, if *x*, that is to say, the space traversed horizontally by the frame, is proportional to the time, *t* (this being obtained by a clockwork movement), and if *tga* is proportional to the product, EI, of the difference of potential between two points through the intensity of the current circulating between such points (it being possible to obtain this by my measurer of energy), we obtain, on multiplying a constant, K, which depends on the construction of the apparatus,

$$y = k \int \mathrm{EI}\ dt.$$

Then the angles described by the cylinder, C, around its axis are proportional to the quantities of energy expended during the time, *t*. As will be seen, there is no difference between this apparatus and the one that has been adopted by Mr. Boys. —*M. Deprez, in La Lumiere Electrique.*

COMMERCIAL ALBUMEN.*

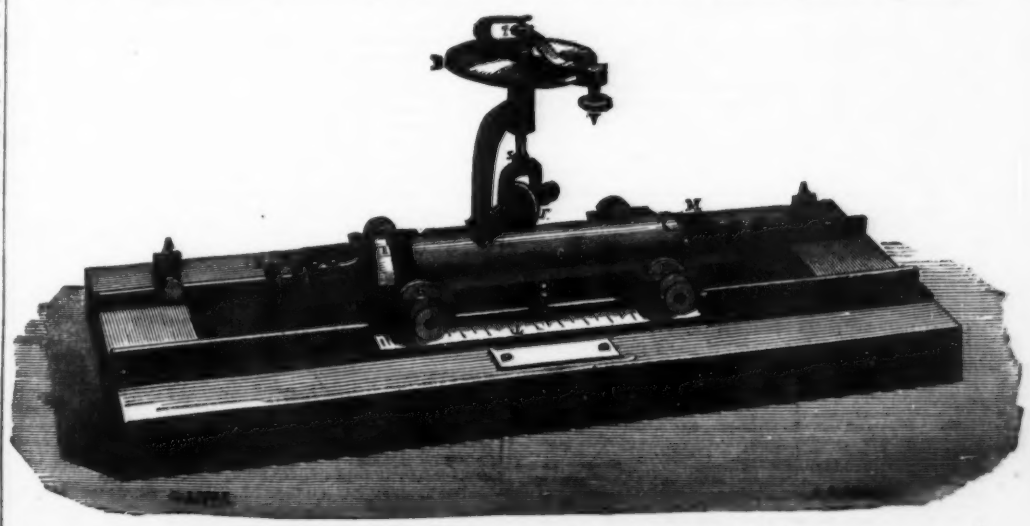
By ALFRED H. ALLEN.

THE applications of albumen are now very numerous, and as it differs much in quality, according to its origin and the details of its preparation, it is sometimes necessary to ascertain its purity and freedom from adulteration.

Commercial albumen is obtained chiefly from two sources —eggs, and the serum of blood. Fish-albumen is also met with occasionally, and may be recognized by its fishy odor.

Blood or serum-albumen is obtained by separating the serum from the clot of perfectly fresh blood. The liquid is evaporated in shallow trays, at a temperature not exceeding 50° C., when the albumen is obtained in brittle scales or transparent flakes of a grayish, yellowish, reddish, brown, or black color. The qualities of serum albumen, made by leading firms, are "refined," "prime," "No. 1," "No. 2," and "black." *Refined* is made from highly rectified serum, and is of a dirty yellow color, and, like *prime*, is employed for printing delicate colors. No. 1 is darker in color and less valued, though suitable for all ordinary printing purposes. No. 2 quality is made from the second draining of the serum, which, after the clear top serum has been siphoned off, is more or less tinged with red, and consequently is only fit for printing dark colors; as a rule, it

* Read before the Society of Public Analysts on 15th November, 1882.



ABAKANOWICZ'S TOTALIZING INTEGRATOR.

also contains some insoluble matter, which is objectionable. *Black albumen* or "dried blood" is obtained from the last portions of serum, and is almost black in color. It is not used in calico-printing, but finds applications in sugar-refining and turkey-red dyeing. The clot, left after separation of all serum, consists chiefly of fibrin and blood-corpuscles, and is dried, roasted, and used as manure.

Serum albumen may be employed for printing all but the very finest and brightest colors. Perfectly colorless blood-albumen, equal to the finest egg-albumen, is said to have been recently produced in Germany.

Egg-albumen is obtained in a solid state by cautiously evaporating the white of eggs, at a temperature below 50° C. It is generally transparent, and of a light yellow color. It is more valuable than serum-albumen, and consequently is more liable to adulteration. Two genuine qualities are made. Egg-albumen should be free from blisters, which are often present in partially coagulated samples.

Albumen of good quality is recognized by its transparency when in flakes, by its taste, not being disagreeable, and by having no odor of putrefaction. Treated with cold water, with constant stirring, it should dissolve entirely.*

Commercial albumen is liable to adulteration with gum, dextrin, flour, sugar, etc. For its examination, 5 grammes of the powdered sample should be treated with 50 c.c. of cold water, with frequent stirring, until all soluble matter is dissolved. Pure and good samples leave no residue. A few drops of acetic acid should next be added, and any undissolved matter filtered off through silk or fine muslin. It may consist of coagulated albumen, casein, starch, or membranous matter. The casein may be dissolved out by treatment with very dilute caustic soda, and precipitated by exactly neutralizing its solution with acetic acid. The aqueous solution of the sample is boiled, when the albumen is thrown down as a flocculent precipitate, which may be filtered off, washed, and weighed, or ignited with soda-lime, and the albumen deduced from the ammonia obtained. The filtrate should be treated with acetic acid and potassium ferrocyanide to make sure that no albuminoid remains in solution.† Its absence being proved, tannin may be added to precipitate any gelatin; and the filtrate concentrated to a small bulk and treated with alcohol to precipitate any gum or dextrin, while sugar, if present, will remain in solution in the alcoholic liquid, and may be detected by boiling off the alcohol, heating with hydrochloric acid, and testing the liquid with Fehling's solution. Sugar might also be extracted by treating the original solid sample with alcohol.

Ziegler's method of assaying commercial albumen is to dissolve 20 grammes of the sample in 100 c.c. of cold water, strain through a sieve, and add 100 c.c. of the clarified liquid boiling 20 per cent. solution of alum. After noting the appearance and volume of the coagulum, it is washed, dried, and weighed. De Coninck (*Journ. Chem. Soc.*, xxv., 1,129) finds that the process gives a precipitate containing not more than 1 per cent. of alumina, and that it is sufficiently accurate for the purposes of the calico-printer. With pure albumen very good results are obtainable, and their accuracy is not affected by the presence of dextrin, but gum-arabic prevents the precipitation of albumen to a very notable extent.

I have made some observations on the proportion of ash yielded by various qualities of commercial albumen, and the results have some interest, although they are not applicable to the detection of any special adulterants. The proportion of ash cannot be readily ascertained by direct ignition of the albumen, owing to the fusible nature of the carbonate of sodium and other salts of which the ash is mainly composed. The difficulty may be obviated by treating a weighed quantity of the sample in a porcelain crucible with nitric acid of 1·42 specific gravity and two or three drops of strong sulphuric acid. On heating gently, the albumen dissolves to a clear yellow liquid, which may be evaporated to dryness, without trouble, giving a residue which readily burns, and leaves an ash of tolerably high melting point. Operating in this manner, Mr. J. C. Belcher obtained in my laboratory the following percentages of "sulphated ash" from a series of samples of commercial albumen manufactured by a leading firm:

	Sulphated Ash.
"No. 1" egg albumen	7·4 per cent.
"No. 2" " "	7·0 " "
"Refined" blood albumen	9·1 " "
"Prime" " "	8·5 " "
"No. 1" " "	9·2 " "
"No. 2" " "	8·9 " "
"No. 3" " "	9·7 " "
"Black" " "	6·2 " "

All the ashes were white, except that yielded by the black albumen, which gave a reddish ash, owing to the presence of blood corpuscles in the original sample. Curiously enough, in this, the lowest grade of genuine albumen, the ash is less than in the better kinds.

A BISMUTHIC HAIR-DYE.

By A. NAQUET.

THE author states that he was induced by a knowledge of the injurious properties of the many hair-dyes that are put forward as perfectly harmless to make the attempt to produce one that should be fairly entitled to that description. While working upon the subject he protected the different steps by patents, in order to secure priority, but having attained what he considers to be a satisfactory result, he has now abandoned his rights for the public benefit.

M. Naquet's experiments were made in the direction of compounding a metallic tincture that should have an innocuous metal for a basis instead of lead, and for this purpose he selected bismuth. The preparation which was the subject of his first patent consisted of two solutions that were mixed immediately before being used, and he describes the method of making it as follows.

It has long been known that a solution of bismuth is obtained in treating bismuthic hydrate with a solution of bitartrate of sodium; but it is not very easy to prepare, and not more than a very small proportion of the bismuthic hydrate employed is ever dissolved. M. Naquet therefore sought an easy method of preparing the double tartrate of potassium (or sodium) and bismuthyl ($C_4H_4NaBiO_6$). The bismuth is dissolved in the smallest possible quantity of nitric acid, and to this is added an aqueous solution of tartaric acid (3 parts of acid to 5 of bismuth) and a large quantity of water; the whole is then thrown on a filter and the precipitate washed. The wash water contains some bismuth, which can be removed by precipitating with a sulphide, then redissolved in nitric acid and used in a subsequent operation. The well washed precipitate, while still moist, is dissolved in a boiling solution of sodic bitartrate (12 to 15 parts of bitartrate to 5 of bismuth), then filtered, diluted with water, alcohol, and glycerine, and again filtered. Each liter should contain 150 c. c. of glycerine, 150 c. c. of alcohol, and 600 c. c. of water. The proportion of bismuth present should be 2 grammes of metal per 1,000, and if the liquor contains more or less it should be brought to that strength. The paper through which this liquid is filtered will retain some bismuth, precipitated by the alcohol; this can be redissolved in nitric acid and again used.

The bismuthic solution alone does not dye, but mixed with sodium hyposulphite it soon deposits sulphide of bismuth, which dyes the beard and hair. But as this mixture is quickly decomposed, it must not be made until just as it is going to be used. This form of bismuthic hair-dye, therefore, requires to be sent out in two bottles, one containing the bismuthic solution, the other the solution of sodium hyposulphite (1 part of solution saturated in the cold diluted with 5 parts of water). When required for use, these are mixed together in equal proportions.

The bismuthic product precipitated by tartaric acid and water can be dissolved by means of carbonate of potash, or by any of the caustic or carbonated alkalies, including ammonia, the liquid being after neutralized by a current of carbonic acid gas and filtered. But unfortunately this neutral product, or even one slightly alkaline, does not act as a dye when mixed with either hyposulphite of soda or flowers of sulphur. It can only be used by moistening the hair first with the bismuthic liquid, and then, after it has dried, with a solution of sulphydric acid or a sulphide.

This dye is said to have a progressive action, and to produce all the shades from a light flaxen to a deep chestnut color, according to the number of applications made.

The second patent was taken out for a preparation that could be sent out in one bottle, M. Naquet, while pursuing his investigation, having found that an ammoniacal solution of the tartrobismuthic product will keep indefinitely when mixed with solution of hyposulphite of soda, if the containing bottle be kept well closed. Such a mixture is said to make an admirable hair-dye, it decomposing and depositing sulphide of bismuth in proportion as it loses ammonia and is acted upon by carbonic acid in the atmosphere. The degree of concentration of the liquid is not of great importance, nor the quantity of ammonia. The following is the working formula given by M. Naquet:

Dissolve 100 parts of bismuth in the smallest possible quantity of ordinary nitric acid (about 280 parts). To this liquor add a solution of 75 parts of tartaric acid in water, and then a rather considerable quantity of water to insure complete precipitation. The whole is then thrown upon a filter and the residue washed with water until the washings are no longer acid. The magma left on the filter is then put into a dish, and solution of ammonia gradually stirred in until all is dissolved. The magma derived from 1½ kilogrammes of bismuth will require 0·8 or 0·9 liter of ammonia. To this liquor is added 75 parts of hyposulphite of soda in powder, and when the salt is dissolved the product is filtered and put into bottles. In this state it is ready for sending into commerce, but it is of advantage to add 1 or 2 per cent. of glycerine; no addition of alcohol is necessary. The liquid so prepared would contain about 5 per cent. of bismuth. It may be further diluted with water if desired.

The hair or beard when saturated with this liquid acquires after five or six hours a deep chestnut color. Upon washing the hair, this color disappears, giving place to a delicate flaxen color. By repeating the operation daily a stage is arrived at when, after passing through all the intermediate shades, the deep chestnut color remains persistent.—*Phar. Jour. and Trans., September* 16, 1882, *from Moniteur Scientifique* [3], xii., 880.

FORCED FEEDING IN PHTHISIS.

THE practice known as forced feeding, or "super-alimentation," introduced by MM. Debové and Dujardin Beaumetz, of Paris, has begun to attract some attention. This super-alimentation consists in forcing into the patient's stomach, by means of a sound, large quantities of highly concentrated food. It was first employed in phthisical patients who could not retain food on the stomach when taken in the ordinary way. Strange to say, these patients endured the unpleasantness of stomach-tubes, kept down the injected food, and improved in health. The method has now been extended to cases of hysteria with vomiting, also to dyspepsia and to various wasting diseases when the stomach is rebellious.

The food used is chiefly meat-powder, which is administered in milk, or bouillon, to which eggs may be added. This meat-powder appears to be a really useful preparation, and, as it need not be expensive, it will doubtless become more widely employed. It is made by taking lean meat, mincing it, spreading the paste on porcelain tables, and letting it dry at a temperature of 90°C. This is then taken and pounded into a powder, when it is ready for use. The dose given at first is small, being about twenty-five grammes at a meal. This amount is gradually increased until between four hundred and six hundred grammes are given daily. Such a dose is the equivalent of about four pounds of fresh meat. The amount of meat in an average diet is only about one pound, and when it is remembered that the meat-powder is administered dissolved in two liters of milk, to which several eggs are added, the significance of the term "super-alimentation "will be understood.

Under such a diet the urine is diminished in amount, but the urea is greatly increased, sometimes reaching eighty grammes per day—the normal amount being 32·5 grammes with an average diet. Sometimes albumen appears in the urine. Diarrhœa may occur, in which case pepsin and bismuth are added.

Phthisical patients rapidly gain weight, we are told, when thus forcibly fed, there being often an average daily increase of from eighty to one hundred grammes. Cough and expectoration diminish, and reparatory processes take place in the lungs. We do not hear it stated, however, to what extent permanent cures are produced.

It is hardly probable that American œsophagi will tamely submit to the introduction of a tube *ter in die*, and it is difficult to understand how such a process proves sedative to irritable stomachs, except in hysterical cases. The meat-powders, and the over-feeding, however, are sufficiently rational measures in many cases.—*Medical Record.*

TREATMENT OF DIPHTHERIA.

DR. J. J. O'DEA, of Stapleton, N. Y., recommends the following and, as he claims, successful local treatment of diphtheria: To the entire inflamed surface surrounding the false membrane, and close up to its border, he applies, by means of a cotton wad, the following solution:

℞.	Argenti nitrat. cryst.	℈ j.
	Spt. æther. nit. dulc.	ʒ iv.
	Aquæ destill.	ʒ iv.
M.		

In the same manner he then makes an application of the following mixture to the surface of the false membrane, and out to its extreme edge, but no further:

℞.	Acid. carbol.	gr. viij.
	Liq. ferri subsulph.	ʒ ijss.
	Acid. sulphurosi	ʒ iijss.
	Glycerinæ.	ʒ j.
M.		

These are to be repeated twice, or possibly three times, in twenty-four hours, the second mixture to be supplemented by a gargle of lime water, thus allaying irritation and removing the debris of false membrane broken down by the action of the acid. When nothing remains of the deposit save some milky white patches, he omits the applications and employs only the lime water gargle or spray.

MEDICAL PROPERTIES OF THE POTATO BUG.

(*Doryphora decemlineata.*)

By JOHN D. FORBES.

Experiments with the Live Beetles.—The beetles were mashed in a mortar, and macerated with different solvents.

Alcohol yielded a dark oily extract, having the characteristic odor, and when mixed with an equal quantity of resin cerate produced no irritation of the skin. The extract redissolved in alcohol and mixed with carbon bisulphide separated into three layers, the lowest of which was dark brown and soluble in water; neither this nor the two light yellow layers above produced irritation of the skin.

Acetic ether yielded a tincture which on treatment with carbon bisulphide separated likewise into three layers, in neither of which the presence of cantharidin was indicated.

Benzine used as a menstruum, and the product treated with bisulphide of carbon, yielded a dark oil and extractive matter, but no trace of cantharidin.

The beetles were exhausted with potassa solution, the liquid neutralized with acid, evaporated, the residue treated with water, and the undissolved portion taken up with alcohol; on evaporation a dark granular mass was left, which, mixed with an equal weight of resin cerate, produced on the skin in three hours slight irritation and redness.

Experiments with the Dried Beetles.—The beetles were killed with ether, dried, powdered, and exhausted by chloroform. On treating the product with carbon bisulphide, a supernatant dark oily layer and a heavier light brown liquid were obtained, of which the former, when applied to the skin of two persons, produced a tingling, burning sensation, and in twelve hours vesicles formed under the irritated surface. The remaining solution, evaporated to dryness and mixed with resin cerate, produced only slight irritation.

It follows from the above that the potato bug contains a vesicating principle, but it is uncertain whether it be identical with cantharidin.—*Amer. Jour. Pharm.*

PHYSICAL EXERCISE.

A LECTURE under the auspices of the Edinburgh Health Society was lately delivered by Dr. Charles Cathcart, Lecturer on Anatomy in the Edinburgh School of Medicine, on "Physical Exercises; their Place and Function." Dr. Cathcart, after defining physical exercise as the "action and use of our bones and muscles," went on to explain the anatomy of the muscles, the manner of their attachment to the bones, and their great capacity of contraction—it being stated that the body was arranged into about 400 separate muscles of various sizes and shapes. No muscle could contract unless stimulated by a nervous impulse coming from the brain or spinal cord. Each muscle had its own particular action, but no muscle ever contracted by itself. They could thus see that the exercise of one part of the body indirectly told upon many others which they did not suspect. Hence the value of vigorous walking, for instance, with the swing of the arms, the balance of the body, and the action of the legs; but hence, also, the danger of movements which were one-sided and often repeated, producing the constant and associated action of certain groups of muscles, which might bring about changes in the bones and alterations in form which no one would suspect.

Going on to consider the effect of muscular exercise on the various functions of the body, Dr. Cathcart first noted the changes it caused in the respiration. They were all familiar with the fact that exercise not only made the heart beat quicker, but caused them to breathe more rapidly and freely and at the same time the amounts of carbonic acid and watery vapor exhaled were much increased. Under ordinary circumstances it had been found that a man drew in 480 cubic inches of air per minute; if he walked four miles an hour he drew in 2,400 cubic inches, and if six miles an hour, 3,360 cubic inches. The muscles, in contraction, used more oxygen and gave out more carbonic acid, consequently a greater demand was made on the lungs. More air was required, and the blood must be driven the faster through them; and that accounted for the shortness of breath and beating of the heart which accompanied any muscular action.

If they looked at the demands made upon the air while a person was taking exercise, they would see how very important it was that the air should be not only large in amount, but also exceedingly pure in quality. Let them take, as an example, an ordinary dancing party. There were more people in the room than it was intended for; the whole company exerted themselves violently—certainly as much as would be equal to walking four miles an hour—and what was the consequence? Not only did they now require five times as much air as they did before, but they were using up the oxygen, and giving out the carbonic acid at a relatively much increased proportion—while people were afraid to open the windows in case of draughts. When they remembered that that was almost always carried on in a blaze of gas light, every burner of which used as much air as four or five men, they could see that those entertainments required serious attention and careful management if they were to be conducted on sound principles of health.

Emphasizing the point that during exercise the lungs

* For practical purposes, the albumen is best dissolved in warm water, of a *maximum* temperature of 45° to 50° C. The albumen should be added gradually, and the liquid constantly stirred. The water should on no account be added to the albumen. The liquid, after straining through a fine silk sieve, is usually mixed with a small proportion of ammonia, turpentine-oil, etc., in order to prevent frothing, and make it work smoothly. Turpentine also tends to prevent putrefaction, but an addition of about 1 per cent. of arsenious oxide is said to be the best preservative.

† Any precipitate produced at this stage will probably consist of casein.

should have the freest possible play, the lecturer said he had been furnished from good authority with an illustration of the effects of custom *versus* humanity and sense in the late Egyptian war. A body of soldiers and another of marines had to make a march of three miles under the burning sun. The soldiers had their tight-fitting jackets, the marines their loose and free costume. Before the march was ended 130 of the soldiers had fallen out, while every man of the sailors continued in his place. He knew of no other difference between the two sets of men but the costume.

The effects of physical exercise on the circulation and on the nervous system were next in turn considered. As to the first, as any unwonted strain must act injuriously on the heart, necessity existed for beginning gradually and systematically any exercise which involved unusual exertion. On the latter point, the reasonableness of relaxation and rest to the brain was insisted on, and muscular exertion commended as one of the best cures of mental overwork. That brain and muscle could be developed at the same time was illustrated by a reference to the oarsmen of Oxford and Cambridge; and the intelligence of the working classes was also cited as a proof that hard and constant physical labor in no way tended to depreciate the quality and strength of brain power.

As to the effects of exercise in expanding the chest some striking facts were given, not the least interesting of which related to a school were physical exercise had been systematically carried out. The effect of regular exercise was shown as follows: New boys, age 14, average chest measurement, 29·2; at 15, 30·6; at 16, 32·0; at 17, 32·6; and at 18, 32·5; while former boys measured respectively 30·6, 32·1, 34·2, 35·8, and 36·8.

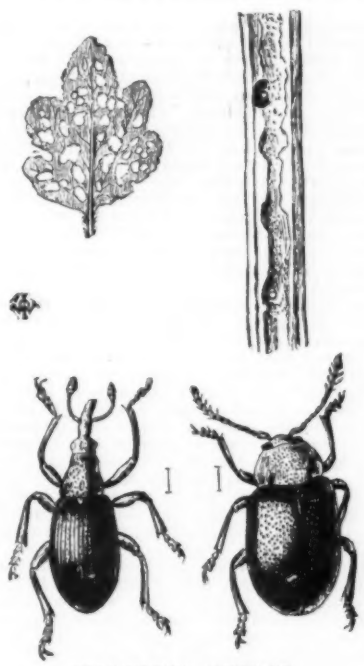
In conclusion Dr. Cathcart laid down some rules for regulation of physical exercise: 1. It should be conducted in an abundance of fresh air, and in costumes allowing free play to the lungs, and of a material which will absorb the moisture, and which, therefore, should be afterward changed—flannel. 2. There should always be a pleasant variety in the exercise, and an active mental stimulus to give interest at the same time. 3. The exercises should as far as possible involve all parts of the body and both sides equally. 4. When severe in character, the exercises should be begun gradually and pursued systematically, leaving off at first as soon as fatigue is felt. 5. For young people the times of physical and mental work should alternate, and for the former the best part of the day should be selected. 6. Active exertion should be neither immediately before nor immediately after a full meal.

[THE GARDENERS' CHRONICLE.]

GARDEN PESTS

HOLLYHOCK INSECTS.

THE large size of the hollyhock naturally induces a number of insect enemies to attack it, in addition to the various species of fungoid parasites. In a previous issue we described the proceedings of the larvæ of a small moth which



HOLLYHOCK BEETLES.

attack the seed buds of this plant, and we now give figures of two other insects which we have found to be still more injurious.

The first of these is a small pretty beetle belonging to the family Chrysomelidæ, named Haltica (Podagrica) fuscipes by Fabricius, Marsham, etc. It is about one-sixth of an inch in length, and is represented magnified in our lower right hand figure. It is of a black color, with the head and thorax orange-red, and the wing-cases high polished, greenish blue-black, and finely punctured; the legs and antennæ are black, the basal joints of the latter organs being fulvous. The hind legs are not nearly so much incrassated as in most of the Halticæ or flea beetles, of which the turnip flea beetle is a well-known example, It very closely resembles the *Chrysomela polygoni*. Linn., but is shorter in proportion to the size of the body. I have found this insect throughout the summer, mostly on hollyhock plants, completely destroying them while of small size at the beginning of May by eating out the whole of the crown of each plant. At a later period of the year, in August, they gnaw holes in the leaves, as represented in our upper left hand figure. I do not know where the eggs are deposited, or where the larvæ are to be found, but suppose the latter feed upon the inner substance of the leaves, forming burrows in the same way as the larvæ of the turnip flea beetle have been ascertained to injure the turnip leaves, or the larvæ of the chrysanthemum or beet leaf miners form mines in the leaves of those plants. For several years my hollyhock plants have been almost eaten up by these little beetles.

The other small beetle represented in our lower left hand figure is one of the small weevils belonging to the genus Apion, named *Apion æneum*. It is about the same length as the Haltica (the natural size of each being indicated by the small line at the side of each figure), but it is more elongated and pear-shaped (whence the generic name); it is of a black color with the upper surface of the elytra very glossy and brassy-green. The head and thorax are finely punctured, the former with a small oval depression between the eyes and the latter with a similar but larger depression in the middle of the hind-part; the rest of the head and thorax is more strongly punctured; the elytra are more finely punctured, and are longitudinally marked with fine impressed lines.

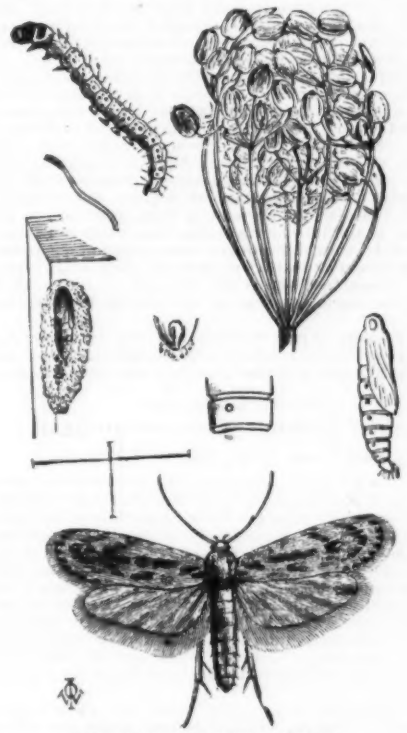
This insect attacks the hollyhock plants in a very different manner to the Haltica, by boring into the pith of the stem of the plant, forming longitudinal burrows and making small circular holes for the passage of the insect, as represented in our upper right hand figure, thus retarding the growth of the plant.

I also obtained from the hollyhock another species of (*Apion malvarem*,) which is ordinarily attached to the mallows, of which natural family the hollyhock is a member. It is smaller than *A. æneum*, and black, without any brassy gloss.

In the month of July I also received from a correspondent a specimen of the small rove beetle (*Oxytelus morsitans*) which had been found in the wounds of diseased hollyhock stems, from which also I obtained several specimen of a minute semi-globose species of Acarid with a very hard skin and of a chestnut-brown color. These latter and the Oxytelus were, however, probably only occasional visitors, attracted to the wounds of the plants by the diseased condition of the vegetable tissues.—*I. O. W.*

THE PARSNIP SEED MOTH.

On July 20 last I received, through the kindness of Miss E. A. Ormerod, some heads of seeds or umbels of the parsnip, each fastened into a mass with fine silken threads by caterpillars of a dirty greenish-gray color, gradually shaded to orange on the under side of the body, and marked above with black tubercles. The head is black and shining, with a white transverse line at the base of the clypeus or upper lip; the following or second segment bears a large semi-lunate black patch, divided in the middle by a slender longitudinal pale line; the following segments are each marked with a row of six black tubercles across the anterior part, each producing a slender bristle, and followed by four other similar tubercles, two being placed just above the legs, the anterior of which latter are black, and the ventral feet yellowish; the terminal segment forms a yellowish plate. When stretched to its full length the caterpillar is three-quarters of an inch long, and rather slender. When disturbed in its abode it leaves it, wriggling about with great



THE PARSNIP SEED MOTH.

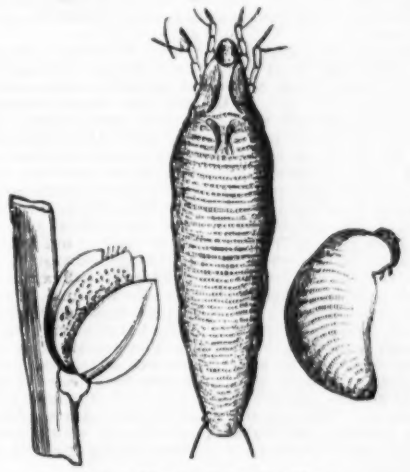
activity, and letting itself fall by a slender web spun from the mouth. It left the parsnip seed at the beginning of August, and spun a slender white silken cocoon in the angle of the box in which it was kept. The chrysalis is represented magnified to about twice the natural length in the accompanying woodcut. It is of the usual form, but the abdominal segments are constricted at the base of each, and they are not furnished with any of the rows of minute recurved points, seen in some chrysalids, as in that of the grape vine moth (*Tortrix angustiorana*). The extremity of the body is entire, with about eight very slender short bristles slightly knobbed and bent at the apex of each. It is chestnut-brown and shining, with the front of the body darker colored. The moth made its appearance from the chrysalis on August 24 last. It measures one inch in the expanse of the fore wings; it is entirely of a pale drab or grayish-ocher color, the fore wings marked with a number of short darker dashes, forming a series of darker curves upon the pale ground of the wings; the two largest of these dashes occur in the middle of these wings, just beyond the center, and following close upon a small round whitish dot; along, and just within the apical margin of the wing, is a row of small dusky spots; the hind wings, and the fringe of all the wings and the body, are silvery pale ocherous-gray.

The moth is the *Depressaria heraclina* of De Geer, Haworth, and other authors, and is described, and the larva figured, by Bruand in the *Annales* of the French Entomological Society for 1844, under the name of *Hæmylis pastinacella*, since, although the *Heracleum sphondylium* is its most constant food, it frequently occurs on *Pastinaca sativa*. Mr. Stainton has given an excellent figure of the moth and its larva in the sixth volume of his *Natural History of the Tineina*, plate iii., Fig. 2, with the following account of its mode of life: "The egg of this species is no doubt deposited in the spring on the undeveloped umbels of the Heracleum by the hibernated female. The larva feeds on the buds and flowers, which it spins together by means of silk, and so forms a concealed gallery within which it works its way across the surface of the umbel. The feeding larvæ may be found in the months of June and July; those which are the later developed do not suffer because the period of the flowering of the plant is passed, as the seeds are equally to their taste, and it seems a matter of perfect indifference to them whether the plant is in blossom or in fruit. The larva is moderately gregarious, there being generally several specimens on one plant. When the larva is full-fed it bores into the stem of the plant, generally entering at an axil of the leaf. When inside the stem it spins a slight white cocoon, and then assumes the pupa state. In three or four weeks the perfect insect makes its appearance, but its habits are very retired, and it is seldom seen on the wing till after hibernation; stragglers are not unfrequently found in houses during the winter months."

Another species of Depressaria (*D. daucella*) also feeds on the parsnip, as well as upon the flowers and seeds of the carrot, sometimes destroying the entire crop; when the latter were attacked, M. Bouche, the gardener of Berlin, planted seeds of parsnip in his carrot beds or fields, the Depressaria moths being attracted to the parsnips in preference to the carrots.—*I. O. Westwood.*

THE CURRANT BUD DISEASE.

For some years past black currants in the West of Scotland have suffered severely from a form of disease known as "double bud," which renders the plants fruitless, and consequently unfit for cultivation, and for which no satisfactory remedy seems generally known. Any information regarding it—either cause, prevention, or cure—would be a



THE CURRANT BUD MITE.

great boon to gardeners in these districts, very many of whom are at present compelled to destroy the bushes they have, as their only recourse before putting in fresh plantations, to secure, if possible, a few years' crops, before these new plants go the way of their predecessors.—*W. L., Pollokshields, Glasgow.* [The cause of the disease is a mite shown in the above engraving. We know of no other remedy than severe pruning and burning, but print our correspondent's letter in the hope of gaining further information.—ED. G. C.]

THE KOLA NUT TREE.

By THOMAS CHRISTY, F.L.S.

I INTRODUCED the kola nut (*Sterculia acuminata*) into England about eight years since and it has lately been subjected to European analyses,* and the results obtained made it exceedingly likely that a large European demand will soon exist. It has been found to contain the same active principle, viz., caffeine, and more of it than the best coffee, and to contain also the same active principle as cocoa, but less fatty matter. Possessing the same qualities as these favorite beverages, it only needs proper treatment to develop a special flavor, and it would then probably be able to compete successfully with those beverages. The nuts are used to form a refreshing and invigorating drink throughout a large portion of tropical Africa, their use being said to support the strength, allay inordinate appetite, assuage thirst, and promote digestion, and to render those using them capable of prolonged fatigue. The negroes prefer them to tea or coffee, and when they can obtain kola nuts, will not touch coffee. Dr. Daniell says of them: "It would be difficult to find any product which constitutes such an important article of commerce in Soudan as the kola nut." Wherever the negro has been transplanted to a foreign country, he has taken the kola nut with him.

As a medium of exchange for the products of Central Africa, no article could be more advantageous, and on this account alone the tree will well repay cultivation. Moreover, if once introduced as a beverage in civilized countries, the demand for it would soon become enormous.

I have recently been informed by Mr. Espeut, a well-known sugar planter of Jamaica, that the negroes use the kola nut as a remedy for drunkenness; that swallowing a single nut, ground up and made into a cream or paste with water or spirit, no sign of intoxication remains half an hour afterward.

Confirmatory evidence of this property in the kola nut is given by a surgeon, Mr. Papeffo, who tells me that alcoholic drinks do not produce intoxicating effects when the kola nut is eaten at the same time.

It appears, therefore, that the craving for drink, which is such a strong incentive to drunkenness, may be subdued by the use of this valuable stimulant and tonic, as after chewing kola nut great disinclination is felt to all forms of alcohol. It has also been found to possess a beneficial action on the liver, its continual use preventing attacks of despondency, to which negroes are peculiarly liable. Dr. Daniell records a case of this kind, in which the kola nut put a stop to an

* See "New Commercial Plants," Nos III. and VI.

epidemic of suicidal mania, which threatened at one time to depopulate the estate on which it occurred.

It is also used by the natives when in a low state of health, suffering from the skin cracking and peeling on the hands and feet.

I have just received from a native gentleman on the west coast of Africa a fair quantity of fruit in splendid order, as fresh as if just gathered from the tree.

Planters will be able to send them off for seed at once to their estates.

Some have been sent to the leading medical men in London for further experiment, and I am endeavoring to ascertain the best plan of preserving their medicinal properties.

JAPANESE SOILS—A NATURAL CEMENT.*

By Dr. O. KORSCHELT.

THE author of this paper, the chemist to the Geological Survey Department of the Japanese Government, was led to look for a natural cement. Such cements are formed by mixing burnt lime with substances of volcanic origin, generally tufas. Since a preliminary burning is not necessary, neither in many cases any grinding, the cement can be formed on the spot where it is required for building without the intervention of any special factory, such as is required for Portland or Roman cement. Materials for the manufacture of such cements have been found in a few places in Europe; in Italy, between Rome and Viterbo, and near Naples at Pozzuoli (whence *Pozzolana*); in Germany, at Brohl thal and Nettethal, near the Laacher See; near Andernach and Neuwied on the Rhine, and in the Riesgau; also in the north of Ireland and in Auvergne. Those from Germany and the last-named places are known, when in the powdered condition, as *trass;* they all contain constituents which are soluble in hydrochloric acid to the extent of about one-half their weight. Besides these, the island of Santorin, and one or two other Grecian islands, furnish a silicious earth, used for the same purpose, which is insoluble in hydrochloric acid, but contains much silica, soluble in potash solution.

Dr. Korschelt first experimented with the tufa rocks of Japan, which differ from those used in Europe for making cements in being chiefly augite-andesite and trachyte, while the European rocks are, for the most part, leucite-bearing tufas: experiments with these rocks were unsuccessful. It was noticed, however, that some of the soils of Japan yielded a large amount of matter to cold concentrated hydrochloric acid, and contained large quantities of hydrated oxides of iron and aluminum. Layers of soil, 25 centimeters in thickness, to a depth of 1·5 meters, taken from the city of Tokio (Yedo), were analyzed. The dry soil from one of the low lands gave up from 75 to 80 per cent. to hot hydrochloric acid; of this, about 30 per cent. was silica, and 30 per cent. alumina and ferric oxide. From 1·5 to 3 per cent. of potash, soluble in hydrochloric acid, was found in the lower layers of this soil, but this is an unusual amount. These soils are generally called loams, but chemically they can scarcely come into that class, as they contain little or no quartz sand, and only about 10 per cent. of mineral sand, but 50 to 60 per cent. of easily decomposable silicates of the nature of zeolites, and about 30 per cent. of aluminum and iron hydrates. The insoluble mineral sand consists principally of sanidine and plagioclastic feldspar, with a little augite, the tufa from which it is formed being trachytic or augite-andesite.

These tufa soils have a very low specific gravity, less than that of all other soils, excepting only peaty soils. In fifteen samples the specific gravity varied from 2·097 to 2·291, the mean being 2·156; while the *apparent* specific weight, obtained by dividing the absolute weight of a given volume of the soil in its natural condition by the weight of an equal volume of water, was between 1·038 and 1·270, the mean being 1·135.

Mechanical analyses were made of twenty-two samples by means of Schöne's and Ort's apparatus. Only about 3 per cent. of the soil particles had a greater diameter than 0·5 millimeter, and about 70 per cent. were less than 0·09 millimeter in diameter. It was also found that the physical composition of the soils varied comparatively slightly, either with varying depth or from different localities. The chemical composition of these tufa soils also varies but little. We give the analyses of one series from a village in Saitama Ken as an example:

	Depth of Soil in Centimeters.				
	0—25.	25—37.	37—50.	50—75.	75-100.
Hygroscopic water	12·49	13·01	14·90	18·34	19·10
Loss on ignition	29·99	32·66	30·68	32·28	33·10
Alumina	8 30	9·81	11·07	11·33	11·40
Ferric oxide	5·95	6 20	6·79	9·24	8·66
Lime	0·69	0·60	0·32	0·21	0·15
Magnesia	0·34	0·34	0·44	0·32	0·37
Potash	0·05	0·07	0·06	0·05	0·06
Sulphur trioxide	0·07	0·09	0·07	0·07	0·12
Phosphorus pentoxide	0·07	0·07	0·05	0·07	0·07
Carbon dioxide	0·08	0·07	—	—	—
Carbon	7 23	6·30	2·86	1·56	1·63
Nitrogen	0·39	0.35	0·18	0·12	0·12

Some of these tufa soils, which were of a whitish color, refused to form a satisfactory cement when mixed with lime, but those of a reddish-yellow or reddish-brown color, when mixed with lime paste, quickly set and hardened, forming a highly satisfactory cement. The chemical action taking place at the time of mixing was indicated by a rise in temperature of 7° C. Suitable soils were found on nearly all the high parts of Tokio, and to a depth of about twenty feet. Complete analyses of some typical specimens are given, and the composition of a suitable tufa earth is stated to be as follows: Organic matter, 1 per cent.; zeolites and hydrates of sesquioxides, 85; clay, 1·5; quartz sand, 1·5; and mineral sand, 11 per cent. The most suitable mixture was found to be one volume of burnt lime, made to a stiff paste, mixed with six volumes of earth. The hardness of the cement was found to be sufficient for most purposes, and also its resistance to crushing, although this latter could not be determined with exactness, owing to the want of a testing apparatus; however, it always resisted a pressure of over 12 kilogrammes per square centimeter on a thickness of 3 centimeters. It is also impermeable to water. Experiments were also made by mixing the earth with sand before adding the lime; this increased the density and value of the cement, but is not to be generally recommended, owing to the difficulty of obtaining sand sufficiently sharp for the purpose; in many places, however, a pumice-tufa is met with which answers admirably for mixing with the earth.

The tufa earth is met with over a large part of Japan, and in many different districts. Its value for the building of dwelling-houses can scarcely be overrated. From its abundance, houses can be constructed of it as cheaply as, if not more cheaply, than of wood, and by its means the fearfully destructive fires, which are estimated to burn down the whole of any large town within ten years, would be to a large extent prevented.* The habits of the people would not allow of brick or cement houses being generally adopted at once, but there could be no objection to the two side-walls of the house being of this cement.

In a postscript the author states that he finds that a decomposed granite grit, found in parts of Japan where the tufa is absent, forms an excellent cement material, and is indeed a most acceptable supplement to the tufa earths.

Dr. Korschelt makes some suggestions as to a new system of soil nomenclature by which the confusion now arising from using certain terms, such as sand and clay, sometimes in a chemical sense and sometimes in a physical sense, would be avoided. The six chemical constituents, clay, sand (quartz), mineral grains (other than quartz), zeolites, including hydrates of sesquioxides, carbonate of lime, and humus, are taken as the basis of chemical distinctions, and the fine earth is divided according to the diameter of the particles, ascertained by the mechanical analysis, into four principal divisions; by making compound words, often of some length, denoting the chemical and physical constituents, the constitution of any soil can be expressed with accuracy.

The results of previous investigations of Japanese soils, and remarks on their agricultural value, are given. E. Kinch (*Transactions of the Asiatic Society of Japan*, 1880) analyzed several soils; among these were four tufa soils differing but little in composition from those examined by the author. These soils all contained magnetic oxide of iron, as indeed do the great majority of Japanese soils, and in the surface-soil the amount is much larger than in the subsoil, indicating a considerable denudation, whereby the heavy magnetic oxide was left, and accumulated in the top soil. The views of D Brauns on the geology of the neighborhood of Tokio ("Memoirs of the University of Tokio," No. 4) are criticised and dissented from.

In considering the agricultural attributes of these soils the author indorses the view expressed by Kinch (*loc. cit.*), that these soils are admirably adapted from their physical properties, to the system of agriculture pursued by the Japanese farmer, but that, viewed as a storehouse of plant-food, they are usually poor. They contain a very large amount of the finest particles, but are quickly and easily cultivated and sufficiently adherent. They possess great absorbent and retentive powers for water, and their dark color is favorable to the absorption of heat. Moreover, the large amount of zeolitic matter they contain gives them powerful absorptive powers for many kinds of plant-food, and renders them very thankful for rich manuring.

In general manuring, cropping, and cultivation the Japanese farmer has but little to learn from the European, but rather the converse; he fails, however, in knowledge of special manures, and the smallness of his holdings prevents many improvements in implements, and in other ways

The analyses of soils given by Dr. Korschelt show a gradual decrease of combined nitrogen from the surface-soil downward in a very interesting manner. In one series taken at different depths the nitrogen in the top layer of 25 centimeters is very large in amount, being 0·521 per cent, and decreasing steadily, till at 1 meter depth it is but 0·131 per cent. In another series, the surface-soil contains 0·372 per cent., which decreases to 0·095 at one and a half meters depth. In another, the decrease is from 0·208 to 0·08 per cent.; and again, in a fourth series, from 0·396 at the surface to 0·124 per cent of nitrogen at the depth of one meter. When we remember that 0·1 per cent. in such a soil means 3,000 lb. of combined nitrogen in one acre to the depth of one foot, the immense stores of nitrogen in the soils are realized.

The percentage of carbon in the soils from Saitama is also very high, and the ratio between the amount of carbon and that of the nitrogen is higher than has been found in most soils.

* Abstract of paper in *Mittheilungen der Deutschen Gesellschaft fur Natur und Volkerkunde Ostasiens*, 1881.—*Chem. News.*

UNWRITTEN HISTORY, AND HOW TO READ IT.†

By JOHN EVANS, D.C.L., LL.D., F.R.S., etc.

IT has now for some years been the custom at the meetings of the British Association for the Advancement of Science, for one of its members to be deputed to deliver a lecture, not to his fellow members, for whom in the ordinary programme an amply sufficient supply of mental food has been provided, but to the operative classes in the town where the annual meeting happens to be held. Such a custom has much to commend it, for all alike—the rich and the poor, the worker with the head and the worker with the hand—are interested in the advancement of that science, or "natural knowledge," for the promotion of which this association, like its elder brother, the Royal Society, was founded.

An occasion like the present, moreover, gives a good opportunity of treating of some subject which lies within the range of all observers of what is going on in the world around them, which may even be of local interest, or to speculate on which may give an additional zest to an evening stroll or a day's relaxation from toil. It is not, however, easy to find a subject of this kind; and yet, perhaps, if I talk to you this evening of those who, in times more or less remote from the present day, have lived and labored in this part of the globe, I shall at all events have a theme of some general human interest. And if, in addition to laying some particulars of their method of life before you, I can point out the methods by which our knowledge of the manners and customs of remote antiquity is obtained; if I show you the way in which the successive links in the chain of circumstantial evidence relating to human progress are forged, you will be able to appreciate the value of the application of scientific methods to the study of the past, and to feel that our present knowledge of antiquity rests upon something more secure than vague conjecture. It is fortunate for me that in and around this town of Southampton is what may be termed the home of some of the witnesses I propose to call, so that if I am able to interest you in what they have to reveal, many of you will have the opportunity of examining them and cross-examining them yourselves at your leisure. The subject of my lecture, "Unwritten History, and how to Read It," is, as you may imagine, one in which testimony of various kinds is admissible; and, as in the case of many of the most important trials, much may depend upon what, at first sight, would appear to be a trivial common matter.

The term which I have used, "Unwritten History," is so comprehensive that it might be made to embrace the whole series of events which have happened in this world from its first creation until the written annals of the historian begin. It might be expanded so as to comprise the whole of the geological record, as exhibited by the testimony of the rocks, and even to go back to a time when it seems probable that the elements composing our globe had not been consolidated, but existed in a gaseous condition. I propose, however, to limit the term this evening, so that it may not extend beyond the period during which the human race has dwelt upon the earth. I need hardly say that, compared with the time which geological facts prove that the world has existed, this period of human occupancy is relatively short, however vast it may appear when we come to compare it with the few centuries embraced in our ordinary chronology. But of this it will be time to speak when we have traced back our evidence as far as our present knowledge will enable us to go.

With regard to that evidence, or the means by which we must attempt to read unwritten history, one of the principal aids that can be called in is the written history of the past. The ancient writings of Greek and Roman authors carry us back some three thousand years; while the annals of Egypt and Assyria, and those preserved in the pages of our Bibles, make us to some extent acquainted with the habits and customs of still earlier times. And in the same way the accounts of recent travelers who have been brought in contact with races of men unacquainted with even the most simple appliances of modern civilization, serve to throw a light on what must have been the condition of most of the occupants of other parts of the world before those appliances were known. But, after all, our best evidence is to be derived from the relics of the past which, from time to time, we find buried in the earth, and from the circumstances under which they are discovered. Such relics are often of much service even in illustrating that portion of past time which falls within the limits of written history, especially so far as relates to the habits and customs of every day life, as to which, except incidentally, our chroniclers are usually silent. The "princes and kings" who "flourish or may fade," "the unsuccessful and successful wars" whose records make up the bulk of our histories no doubt possess an interest of their own; but all that relates to the infancy and childhood of the human family and the development of its mental and material resources has for many minds a far greater charm, and much that concerns it is only to be gathered from a study of unwritten history.

But before going back to any really prehistoric times, it will be well to consider briefly a few points in connection with the written history of the town in which we are assembled. It was not always called Southampton, but was in Saxon times known as Hamtune, and under that name appears upon coins struck at the local mint from the middle of the tenth until the middle of the twelfth century. In the same manner Northampton was at one time only known as Hamtune, and it was to distinguish these two towns that the one received the prefix of North and the other of Southampton.

Curiously enough, the name of Hamtune, which appears to be compounded of two well known Saxon words—Ham, our English home, a farm or possession; and Tune, the modern town—is more probably, both at Northampton and at Southampton, connected with the old British name of the river which flows past the town. The Nene of Northamptonshire seems to be called the Antona or Anton, by the Roman historian, Tacitus; and the Test of "Suthamtescire," as the country of this town is called by the Venerable Bede, still retains in part of its course this same name of Anton. The old geographer, Ptolemy, calls Southampton Water the mouths of the river Tris anton, or possibly the three mouths of the Anton; and the Roman town which stood near this place was known by the name of Clausentum, which Camden interprets as a Latinized form of the British Clauth-Anton, the port of Anton.

I shall not attempt to determine the claims of Bittern, or Old Hamtune, to represent the Roman town; but the fact that Roman remains still exist here may be cited as a proof that whatever may have been the encroachments of the sea since Roman times, they have not destroyed all traces of the Roman settlement on this site, nor can the relative positions of the sea and the land have materially altered within the last eighteen hundred years. It will be well to remember this when we hereafter come to consider the antiquity of some of the earlier traces of the presence of man in this part of the world. When, once, in ascending the stream of time, we have passed the date of the Roman occupation of this country, we enter upon the domain of unwritten history, or at all events find ourselves within its border provinces.

Who were the people whom the Romans found here on their arrival, and what was their civilization? Historians give us some information on this point, which is, however, to be supplemented from other sources. Cæsar, whose invasions of Britain date some ninety years earlier than the actual Roman conquest, tells us that the southern part of this island was occupied by Belgic tribes who had come over from the Continent, who for the most part retained their original names, and were often subject to the same chiefs as their brethren on the mainland. Those who occupied this part of Britain appear to have been the Belgæ, whose name at least has on the other side of the channel survived in that of Belgium. The habits and customs of these southern Britons were the same as those of the Gauls. They were acquainted with iron, gold, silver, copper, tin, and bronze, and had, moreover, a coinage of their own. Our knowledge of this coinage is not, however, derived from any ancient historians, but from a study of the coins themselves. By a careful record of the spots where coins of the ancient Britons have been found, we have been able to show that particular forms belong to particular districts, and, in the case of some of the coins which bear inscriptions, to determine the names of British princes, and to fix the districts in which they reigned. Here in Hants, and in the neighboring county of Sussex, we find coins struck by two princes, Tincommius and Verica, as to whom written history is silent, but who appear from their coins to have been the sons of Commius, who probably is the Commius mentioned by Cæsar.

It has been supposed, from a passage in Cæsar's "Commentaries," that the Britons in his time were unacquainted with the use of coined money; but this passage may have been misread. At all events, the coins themselves prove that the supposition is erroneous, and, moreover, that long before Cæsar's time a native coinage existed in Britain. You may ask how this can be proved by coins which bear neither dates nor inscriptions. I will attempt to answer this question, and to show you in what manner this chapter of unwritten history has been read. Coins such as we now know them, struck of a certain weight and with some established

* In the winter of 1880-81, in the city of Tokio alone, considerably more than 20,000 houses were destroyed by fire.

† A lecture to the working classes, delivered at the meeting of the British Association for the Advancement of Science, held at Southampton, August, 1882.

device upon them, were unknown even among the most civilized nations of antiquity until about seven hundred years before Christ; and it was not until about three hundred and fifty years before Christ that any extensive coinage of gold was issued at any one place. About that time some mines were discovered in Macedonia, which produced about £250,000 worth of gold annually. Most of this was converted into coins rather heavier than our sovereigns, by Philip II. of Macedon, the father of Alexander the Great. These coins bore on the one side a head with a laurel wreath upon it, and on the other a Victory in a two horse chariot. The coins were so well known, and gold from other sources was comparatively so scarce, that the use of these pieces, which were known as *Philippi*, spread through the whole of Greece and her colonies along the shores of the Mediterranean. Whether as the result of raids upon Greek towns, or from more peaceful contact with Greek colonies, in what is now the south of France, the Gauls became acquainted with them, recognized their usefulness, and proceeded to strike coins in imitation of them. As was to be expected, the art of these imitations was far inferior to that of the original coins. Each copy in its turn served as a model from which other copies were made, and as is often the case, the copies were in many instances larger than the originals; so that by the time the art of coining had reached the northern part of Gaul, the size of the coin had much increased, and the devices upon it had degenerated into a widespread bust with a laurel wreath, and with the hair arranged in rows of locks of even size behind, and in crescent shaped curls in front, while additions had been made to the original head in the shape of a kind of band around it and an ornamental covering for the neck.

Such coins have been found in considerable numbers in England, principally in our southern counties, and especially in Kent. Of their origin from the Macedonian *Philippus* there can be no doubt; but how are we to judge of their date, and of the length of time that coins were known in Britain before Cæsar's landing? It is in this manner: There are some British princes, whose names are recorded by Roman historians and by Roman inscriptions, and to whom therefore we can assign a fairly certain date; and of some of these princes coins are known. They have on them devices such as at first sight appear almost unintelligible, but which by a succession of intermediate forms occurring on coins without inscriptions upon them, can be traced back to the head with the laurel-wreath, while on the reverse side there is always a horse of more or less barbarous form. We have, therefore, evidence of an uninterrupted succession of coins copied the one from the other, beginning with the coins with the widespread head and ending with the inscribed coins. Now each of these successive copies must have been intended to pass current with the coins from which they were copied, and if they had all been of one weight and of one quality of gold it might have been possible for the whole series to have been struck within no very lengthened terms of years. But, as it happens, there is a great diversity in the weight and fineness of the coins, those with the widespread head being of fine gold, and often weighing nearly 120 grains, and the last of the series being of much baser metal and only weighing about 84 grains. In the process of successive copying only the most striking parts of the device, and those most easy to imitate, such as the wreath and locks of hair, survived, and the face, being more difficult to copy, was the first to disappear. Coins with merely a misshapen lump upon them in lieu of the face usually weigh about 96 grains, and the farther they get from the original the lighter the coins become. Now the original weight of the *Philippus* was 133 grains; and assuming that it was first imitated in B.C. 300, and that the weight had become reduced to 84 grains in B.C. 20, and also that the diminution in weight always went on at the same rate, we find by calculation that the date at which the weight would have become reduced to 120 grains—that of the earliest British coins—is B.C. 226. Probably, however, there was a less tendency to reduce the weight and quality at the beginning than towards the end of the series, but the coins justify us in saying that the inhabitants of southern Britain were sufficient civilized to make use of a coinage about 150 years before Christ, or 100 years before the time of our first Roman visitor, Julius Cæsar, if not indeed at an earlier period.

Besides these gold, silver, and brass or copper coins, with devices upon them derived from Gaulish copies of a Macedonian original, there are other coins cast in tin, with devices in imitation of some coins of Marseilles, in the south of France, which also tell us the same story of a close intercourse with Gaul. Many of these were cast in wooden moulds, as is proved by the grain of the wood being visible in relief upon them. Such coins have been found with iron tools and weapons in the ancient encampment of Mount Caburn, near Lewes; but iron or steel must have been in use for some four or five centuries in this country before the time of Cæsar's invasion.

In graves which must belong to the first few centuries before Christ, we find swords of iron with ornamental bronze sheaths; and there are highly decorated shields with artistic scroll patterns upon them, and sometimes with ornaments of red enamel, which belong to the same period. The warriors of those times had horses and chariots, the latter with iron tires and linch pins to the wheels, and the harness of the former provided with bronze and enameled buckles. Of this Early Iron Age, however, we learn more from the remains of ancient dwellings and cemeteries on the Continent. In one of these cemeteries at Hallstadt, in the Austrian Tyrol, upwards of a thousand graves have been examined; and as it was the custom to bury with the dead a number of objects of an ornamental or useful kind—possibly with the view that they might be of service in a future state of existence—we are able to reconstitute the surrounding conditions of their life. Great care was bestowed upon their weapons, some of the swords having hilts of ivory inlaid with amber, both probably derived from foreign commerce; some daggers had golden sheaths; their helmets were of bronze, as were also their girdles, bracelets, and brooches, which present an infinity of different forms. Their pottery was of graceful shape, and some of it highly ornamented. Many of their vessels were made of bronze, sometimes artistically ornamented, with figures of animals; as, for instance, a milk-cup, the handle of which is in the form of a cow with a calf behind her.

But mixed with these graves containing iron weapons are others in which swords, spear-heads, and hatchets of bronze have been found; and it is a remarkable circumstance that the iron weapons appear to have been imitated from those of bronze. I cannot go into the details of the matter, but I may observe that the forms, though readily cast in bronze, are exceedingly difficult to forge in iron; and the only inference that can be drawn from this fact is this, that the bronze weapons and tools must have been in use at the time when iron was introduced as a substitute for the softer metal.

But if iron or steel thus superseded bronze, there must have been a time when bronze was the only metal in use for weapons and tools, and to this period antiquaries have given the name of the Bronze Age. Such terms as Iron Age, Bronze Age, or Stone Age mean, however, only certain stages of civilization, and not only chronological periods applicable to the whole of the world; for while the inhabitants of one country had acquired a knowledge of iron, and had given up bronze for such weapons as swords, in other countries bronze may still have been in use, and in others again it may have been entirely unknown. Here in the south of Britain iron, as already remarked, is thought to have been in use some four or five centuries B.C., and before that time we have evidence of the prevalence of a Bronze Age in Britain probably for a period of not less than ten centuries. We can read this chapter in our history partly by the contents of ancient grave-mounds or barrows, and partly by means of the bronze objects found dispersed in the soil. Bronze, or, as we now generally call it, gun-metal, is a mixture of copper and tin, and the proportions which produce the toughest and most useful alloy are about nine of copper to one of tin. No doubt in some part of the world, probably Asia, native copper, such as is found in so many countries, was first in use; but at present the traces of this copper-using age are on this side of the Atlantic but faint. On the other side, in some parts of the United States, numerous instruments of pure copper have been found. These have been hammered out cold from native copper, and not cast. Where and when it was discovered that the admixture of a small proportion of the softer metal, tin, made copper harder and more fusible, is at present a mystery; but it is remarkable that the same discovery seems to have been made in the New World as in the Old, for some of the weapons and tools of Peru, made before there was any contact with Europeans, are manufactured from bronze of the ordinary composition. Here in Britain our Bronze Period is well illustrated by relics, representations of some of which are shown upon the wall. The swords, spear-heads, daggers, and shields speak for themselves, and exhibit marvelous skill in the art of casting and hammering out. The various tools may also be recognized, and many, such as the chisels and gouges, do not differ materially from those of the present day. The hatchets or axes are either flat blades, sometimes with wings or flanges at the sides, or are cast with a socket to receive a crooked haft. In this country they are never provided with an eye for the helve like our modern axes. The way in which the socketed form was developed from the flat blade is susceptible of being traced, and we can learn from the hatchets themselves that the art of producing them with a socket was a foreign invention, and not originally discovered in this country. Let me dwell on this for a minute. The flat blade, which was cast in a single open mould and hammered into shape, was no doubt the earliest form. It, moreover, closely resembles some of the earlier hatchets made of another material, to which I shall presently have to call your attention. But these flat blades, it was found, could be rendered stronger by being hammered at the sides so as to form flanges upon them, much like those on modern rails. The blades were next cast with these flanges upon them, and it was then found advantageous to make them expand in the middle of the blade, so as to allow them to embrace the two sides of the split haft in which they were mounted. Eventually these projected wings were hammered over so as to produce a kind of semicircular pocket for the haft on each side of the blade. At this stage a brilliant idea occurred to some ancient founder, and by means of a clay core he produced a single socket in the body of the blade itself, and thus did away with the labor of hammering out the wings on the flat blade and turning them over, and also with the trouble involved in making a deep notch in the haft, so that it might run down each side of the blade. But these semicircular wings had become a recognized feature in this class of hatchets, and out of regard to this fashion the earliest of the socketed blades were cast with the two wings on each face, in imitation of those of the older form. As has so often been the case in such developments, what was at one time of essential service survives at another as a useless ornament. And now comes in this little bit of history which these hatchets enable us to read. It is evident that the first socketed blades must have been cast in a country where the prevailing type of hatchet had the semicircular wings on each face; but this kind of hatchet, though abundant in some parts of the Continent, is very rare in Britain, and we are therefore justified in concluding that the art of casting hatchets with a socket was introduced into this country from abroad. Not but what our native founders cast plenty of hatchets of this socketed pattern when once they were acquainted with it, for the moulds for producing them have been found with lumps of metal and various bronze objects in different parts of the Kingdom.

Not only were the bronze-using people skillful as founders but they understood how to work ornaments in amber and jet as well as in gold, and some few specimens of their ornamental inlaying are such as would do credit to any modern workman. The wooden handle of a bronze dagger found in the grave of a warrior in Wiltshire was inlaid with thousands of minute gold pins, arranged in regular patterns, and the amber pommel of a dagger found in Devonshire was as delicately inlaid with gold as any tortoise-shell patch-box of the last century.

The history of man in the bronze-using stage is, however, better read on the Continent than here. On the shores of many of the lakes of Switzerland, Italy, and the south of France the remains of settlements belonging to the Bronze Age have been discovered. As a safeguard against enemies and wild beasts, it was a custom in those times to construct artificial islands, or platforms carried on piles above the water, on which to erect their dwellings. The same custom also prevailed within the historic period both in Europe and Asia, and something of the same kind was practiced in Ireland, until comparatively recent times. A similar custom has been observed in other parts of the world by modern travelers. In such buildings, from time to time, disastrous fires occurred, and what was thus lost to the original occupants has been preserved beneath the waters for the instruction of long subsequent ages. Their houses seem to have been formed of interlaced boughs smeared over with mud, after the manner we now term "wattle and daub." They understood the art of spinning and weaving both woolen and linen cloth. Of domesticated animals they possessed the dog, ox, sheep, goat, pig, and finally the horse. In this country they hunted the red deer, the roe, the wild boar, the hares, and some other animals. But they also were to some extent agriculturists, and reaped their corn with bronze sickles. They made vessels of various shapes in burnt clay, but were unacquainted with the potter's wheel, though some cups of amber and a soft kind of jet were apparently turned in a lathe. Though using so many and such well-made tools and weapons of bronze, a certain number of appliances for both peaceful and warlike purposes were made of stone. The skins which they prepared as leather were scraped by means of flint scrapers. Their arrow points were made of flint, and their battle-axes and war maces were in this country carefully wrought out of stone. From the number and varieties of the bronze instruments found in Britain, it has been inferred that their use must have extended over several centuries, and it seems probable that the beginning of our Bronze Period dates back to at least some 1,200 or 1,400 years B.C. Such a date also seems to agree fairly well with what we learn from history as to the trading visits of the Phœnicians to this country in search of tin.

But the flint arrow heads and scrapers, and the use of stone for battle axes, carry us back to a still earlier chapter of unwritten history, when, for want of knowledge of bronze or any other serviceable metal, our predecessors, like many a savage people of recent or comparatively recent times, had to make use of such materials as readily came to their hands—like stone, wood, and bone—for all ordinary appliances. With relics of this period, which, so far as those made in stone are concerned, are almost imperishable, the soil of this country in many districts abounds. We also find the tools and weapons of this Stone Age in many of the grave mounds or barrows and beneath the floors of some of our caverns. It is by means of these relics that the history of this period is to be read, but here also much is to be learned from the early lake habitations of southern Europe and from the habits of savages in other lands who are unacquainted with the use of metal. It is indeed somewhat remarkable that those in so low a stage of civilization should have been able to furnish themselves with so many and such perfect appliances made of stone. Not only do we find hatchets and adzes of flint and other hard stones, with their edges carefully ground, but chisels and even gouges or hollowed chisels (though these are rare in Britain), drills or awls, hammers, knives, saws, and scraping tools of various kinds. One of the most common of these is made from a flat splinter, or flake of flint, trimmed at the end to a semicircular scraping edge. We still find such tools in use for the purpose of preparing skins; and we have corroborative evidence of their having been in use in old times for some such purpose, in the fact that the semicircular edge is often worn away and rounded in precisely the way that would result from its being used to scrape a soft but gritty substance, such as leather exposed to dust and dirt. Though skins probably formed the principal clothing, the presence of spindle-whorls—the small fly wheels by which spinning by hand is carried on—in some settlements of the Stone Period, proves that the art of spinning was not unknown, and indeed charred fragments of woven linen cloth have been found in some of the lake dwellings of this age. The stone using people of that time cultivated wheat, barley, and millet for their bread, which they ground into coarse flour by means of rubbing-stones; they flavored their cakes with caraway and poppy seeds, and laid up stores of nuts and walnuts, beech mast and acorns, apples and pears for winter use, and ate all the common wild fruits in their seasons.

All this we learn from the charred remains left at the bottom of the lakes where the pile dwellings were burnt down. The bones thrown away show that not only did they hunt wild animals of the country, but that they had oxen, sheep, and goats, and probably also pigs, as domesticated animals, and the dog was already their faithful companion. Their weapons for the chase were arrows and spears tipped with flint—the former of which, being cheaper than metal and also liable to be lost, remained in use even when bronze was known. They also possibly made use of the sling. Their axes, like modern tomahawks, seemed to have been used both for peaceful and warlike purposes, but in this country at least it is doubtful whether any of the stone battle axes with a hole for the haft belong to an earlier date than the simplest of the bronze daggers. From an examination of the skulls and bones found in the graves of the Stone and Bronze Periods we are able to form an idea of the size of the men of those days, and of the differences between them. From the objects buried with them we can even form some idea of their religious beliefs and hope of a future state. I must not, however, dwell on the details of these chapters in the unwritten history of man in Britain. I may, however, observe that though we may fix within some centuries the date when bronze began to be employed for cutting tools, and stone in consequence began to fall into disuse, we are as yet at a loss to say at how early an epoch the use of the stone hatchets with their edges ground or polished first began. The period during which they were exclusively employed has been called the Neolithic or New Stone Period. It has also been called the Surface Stone Period, as the relics belonging to it are usually found upon or near the surface of the ground, and not at a considerable depth below it like those belonging to an earlier chapter in our history, which actually form constituent parts of extensive geological deposits. There is this also to be observed, that the circumstances under which the stone implements of this period are found prove that no very great alteration in the general features of the country has taken place since the time when they were in use. There was the same disposition of hill and valley; rivers ran along much the same course as now, and at much the same level; the same animals frequented the country, with but few exceptions, and though there may have been incursions of foreign races of men, we find the Stone Age shading off into the Bronze Age, and the latter into the Iron Age, not many centuries before the Roman occupation. Although it is impossible to say for what length of time this Neolithic or Surface Stone Period may have endured in Britain, there is little on the face of the facts which of necessity implies a longer existence for the human race than the six thousand years that used commonly to be assigned to it. In other parts of the world, as for instance in Egypt, there have been circumstances brought to light which prove that the ordinary chronology is insufficient for the history of those countries; and, in addition, there are facts known with regard to the development of language which have led many students to the conclusion that the antiquity of man is much greater than was commonly supposed. And yet five-and-twenty years ago, or less, there was no one who could point to traces of human occupation in Britain of an earlier date than the polished stone instruments. I might, perhaps, make an exception in favor of Mr. John Frere, who, at the beginning of this century, inferred from the circumstances under which some stone weapons were found, that they belonged "to a very remote period indeed, even beyond that of the present world."

If it had been my lot to address you in 1858 instead of in 1882, I should myself have assured you that the earliest chapter in our unwritten history was that which related to the polished stone hatchets, and the other forms of stone weapons and instruments which are found associated with them. At the same time I should not have agreed with Dr. Johnson, that "all that is really known of the ancient state

of Britain is contained in a few pages. We can know no more than the old writers have told us." But within the last twenty years what a lengthened vista of the antiquity of our race has been opened out, and what a marvelous chapter of unwritten history have we not to some extent been able to read!

It is to that chapter that I must now turn, and, in examining it, it will perhaps be best first to state some of the facts which of late years have come to our knowledge, and then to show what inferences have been drawn from them.

Geologists have long been aware that along the valleys of our principal rivers, generally at some height above their present level, and often at some distance from the streams, there are beds of gravel, sand, and brick earth, frequently containing the remains of land and fresh water shells, and the bones of various animals. That these drift deposits were not due to the action of the sea is shown by the absence of sea shells, while the general resemblance of the land and fresh water shells in them to those in the existing stream and valley prove them to have been deposited by fresh water. The presence in the beds of the bones of land animals is also corroborative of this view; while the fact that several of these beasts, such as the great woolly elephant or mammoth, the rhinoceros, hippopotamus, and reindeer, are of species now extinct, or no longer known in Britain, is suggestive of remote antiquity. In some cases shells and bones have not been found, but the position and character of the beds are such as to prove that they belong to the same class, and are of the same age, as those in which such remains occur. Here at Southampton we are on the tongue of land which separates the valleys of the Test and the Itchen, but the drift beds in these valleys have not been as yet very carefully examined above Southampton, though at Swathling an elephant's tooth has been found in the gravel. The next valley westward, that of the Avon, which runs into the sea at Christchurch, has been more productive. Along the valley numerous beds of drifted deposits have been examined, and at Salisbury, besides land and fresh water shells, the bones of elephant, rhinoceros, hyæna, lion, and reindeer have been found in them, as well as those of some other animals, among which the pouched marmot and the Greenland lemming may be mentioned. These are especially indicative of a cold climate, as are also some egg shells of the wild goose, which now only breeds in northern latitudes. Some of the drift beds are at a considerable height, as much as 90 or 100 feet above the existing river, but others are at a much lower level. They consist of materials assorted in much the same manner as would be effected by any existing stream—of gravels more or less coarse where probably the current has been strong, of sand where its force has been less, and of brick earth or mud such as might be deposited by the waters of a flooded river, or brought down the hill-sides by rain. It is impossible to imagine any floods of such magnitude as to fill the valley to the height of 100 feet; but if such floods ever did occur, they would certainly not have deposited coarse gravel at the top of the banks of the stream, but at the bottom of its bed. Nor could we expect to find deposits of loam left half way down the slopes of a river liable to such floods. From these and other grounds we are driven to the conclusion that the beds of drift, which are now 100 feet or more above the existing river, at one time formed a portion of its bed when it ran at a much higher level than at present, and that, by the action of the stream running along it, the valley has since that time been scooped out to its present depth. The climate at the time of the deposit of the high level gravels appears to have been cold, so that both frost and a much larger rainfall may have assisted the stream in producing greater effects upon the valley than it now does. The river also, when left to itself, and neither watched nor embanked, would be far more liable to floods which might wear away the valley. Under any circumstances the scooping out to such a depth must have required an enormous amount of time, and it is hard to picture to one's self what the country must have been like in those days when the beds of the rivers at some little distance from the sea were, say, 100 feet above their present level. Here at Southampton we have beds of these old gravels capping the hill at the Common at something like 150 feet above the sea level, and yet the top of this hill must at the time of their deposit have been the bottom of a valley with hills on either side. As old as the hills is a proverbial phrase, but, compared with the age of the hills at the side of the valley which has disappeared, this hill is a thing of yesterday—

"The hills are shadows, and they flow
From form to form and nothing stands.
They melt like mists the solid lands,
Like clouds they shape themselves and go."

Some of you will begin to think that I have not kept my promise, but have strayed into the geological past. When, however, I tell you that implements made of flint, as undoubtedly the work of intelligent beings as any Sheffield whittle of the present day, form constituent parts of the gravel of which I have been speaking, and are also found scattered through the sands and loam, you will perceive that I am still within the limits of the unwritten history of the human race.

Before proceeding further with regard to the circumstances under which the implements are found, it will be well to say a few words as to their character and probable uses. Some of them are large flat splinters or "flakes" of flint, detached from a block by a single blow, in the same manner as flakes of flint are still produced in the manufacture of gun flints. The edges of such flakes are very sharp, so they may have been used as knives. When found in gravel they have usually been much knocked about, but when found in sand or clay the edges often show traces of wear, as if they had been used for scraping bones or some such hard substance as well as for cutting. The more highly wrought implements are sometimes oval, with a cutting edge all round, and sometimes provided with a sharp or rounded point. The oval specimen shown in the diagram was found in a pit at the north end of Southampton Common, and the other two near Barton, between Lymington and Christchurch. These implements are chipped out with considerable skill, and may have been used either as weapons for the chase or for the war, or as tools for cutting, grubbing, or piercing. The extreme point of one of the specimens figured has been worn away at each side, as if it had been used for boring a hole. Some of the instruments may have been mounted with hafts as axes or spears, but of this there is at present no conclusive evidence. The larger number of them appear to be well adapted for holding in the hand, and it is to be observed that their broad end is usually blunt, and the narrow end sharpened for use; whereas in the instruments of the Surface Stone Period it is nearly always the broad end that is sharpened, and this has often been effected by grinding or polishing the edges, while in the implements of the period we are now considering the edges are never ground.

The name by which this period is generally known is the Palæolithic or Ancient Stone Period, though it is sometimes also termed the River Drift Period as the implements belonging to it are usually found in river drift. Of the other appliances in use among those who made the large Palæolithic implements we can best judge by the remains which have been found beneath the floors of some of the caverns both of England and France, which, however, for the most part probably belong to a somewhat more recent date. In the days when those caverns were occupied as dwellings, the reindeer still formed a principal article of food in the south of France. Those who hunted it were sufficiently good artists to carve figures of it in bone, or to engrave them on slabs of slate. Some representations of the elephant have also been found. They carved harpoons in reindeer horn, prepared skins with stone scrapers, and sewed them together by means of bone needles, probably using reindeer tendons as thread. The men, however, who were in this state of civilization lived at a time when the valleys had been excavated to nearly their present depth. Yet even between them and the people of the Neolithic or Surface Stone Period there appears to be a great gulf—a chapter of unwritten history, which at present we have no means of reading.

Let us now return to the river drift, and see what more it can teach us. I have told you how on the high ground where now is Southampton Common there are beds of gravel containing water worn flint implements, and that these beds must in all probability have been deposited in the bottom of a river valley. Farther south we find gravels of a similar character, but at lower levels, forming cliffs of no great height along the sea-shore from Hambley to Alverstoke. These cliffs are now being eaten away by the action of the sea, and among the pebbles spread by the waves upon the shore numerous well wrought implements have been found, while further east, at Selsey, these are extensive drift beds containing remains of the mammoth. Nor are traces of the river, which deposited these beds, wanting on the other side of Spithead, for in the shingle at Bembridge implements of the same kind have been discovered, and Mr. Codrington found a good specimen, some 80 feet above the present sea level, in gravel on the Foreland at the east end of the Isle of Wight.

It will probably be some little strain upon your powers of imagination for you mentally to fill up the great channel of the sea which we know as Southampton Water, and which now forms the basis of the prosperity of this town, and to picture to yourselves a river flowing in the same direction, spreading out gravels along its changing course at a height considerably above the present sea level, and yet having its shores frequented by that early race of men who fashioned the implements which we find in the gravels. But I shall have to make a still further demand upon your powers of belief.

I have already spoken to you about the drift-deposits along the valley of the Avon, but I must now take you a little further west, and call your attention to discoveries which have been made at Bournemouth. There, as many of you no doubt remember, the cliffs are formed of beds of sand and clay belonging to a period a little older, geologically speaking, than the Bracklesham beds which form the subsoil of Southampton. These cliffs are, however, capped with gravel; and in this, also, at a height of more than 120 feet above the sea-level, implements have been found. Further east, near Boscombe, the height of the gravel is still about 120 feet; at Hengistbury Head it is 90 feet; and at Barton and Hordle, where numerous implements have been found, it is 60 or 70 feet. There can, indeed, be but little doubt that these gravels which now cap the cliffs must originally have been deposited in the bed of a river, and that that river flowed in an easterly direction. But how, it will be asked, can any river have possibly taken such a course? I will ask you, in return, Of what are the Needles at Alum Bay the relics? Are they not the shattered and sea worn remains of an extension of the great chalk ridge of High Down westward from Freshwater? Can you not imagine them still forming part of the down, with other Needles, which have now disappeared, towering still further to the west? Can you not picture to yourselves the foreland of Ballard Down, on the Dorset coast, and its accompanying pinnacles standing out still further to the east, and thus in your mind's eye gradually bridge over the gap of fifteen miles, which now exists between the chalk downs of Dorset and those of the Isle of Wight? There must almost of necessity have been a period when these two ranges of downs formed one continuous ridge, and when, in fact, the Isle of Wight was not separated from England by any arm of the sea. At that time the rivers which now discharge their waters at Poole, at Christchurch, at Lymington, and at Exbury, must all have been contributed to form a river the course of which must have been from west to east, in a direction nearly parallel to the chalk downs. Of the bed of this river we have traces in the gravels which now cap the cliffs of our southern coast. The history of the disappearance of this ancient river appears susceptible of being traced. We know not how far the land may have extended to the south of the chalk downs at the time when it first began to flow; but in the course of long ages the never-ceasing wear of the sea, slow but sure in its action, must have effected a breach through the line of chalk downs, and have then more rapidly cut away some of the softer beds to the north, so as to afford a new means of access by which the waters of the river would find a way to the sea. As time went on this breach would become wider and wider, until, as we see at present, the whole of the southern slope of the old river valley disappeared for a distance of fifteen miles between Ballard Down and the Needles; while that part of the bed of the old river which still had land to the south was widened out until it became the Solent Sea and Spithead, which now separates the Isle of White from the mainland.

I might have given you evidence from which it has been concluded that, at the period when the river gravels containing flint implements were deposited, England was still united to the Continent, and the Straits of Dover did not exist. I might have pointed out the existence of similar implements discovered under nearly similar circumstances in remote quarters of the world. But time will not suffice, and you must be content with my attempt to read this chapter of local history. I must, however, warn you against supposing that, old as may be these relics, they represent the first advent of man upon the earth. On the contrary, their similarity in so many regions points to some early home of the human family from which the makers of these flint tools in different countries originally migrated. Of this home, however, as yet no traces have been found. As to the number of years embraced in this chapter of the river drift it is hard even to speculate. It can only be judged by the changes which have since taken place. We have seen how in the Roman times this part of Britain was, so far as the distribution of land and water is concerned, much the same as at present, and that there can have been but little difference in the days when bronze was in use for cutting-tools, or in that lengthened period when stone did duty for steel. But when we come to this earlier chapter in our history, all is changed. We find on the top of our hills and the capping of our cliffs gravels which must have been deposited at the bottom of rivers, but which testify to the existence of man at the time of their deposit. We find a total change in the animal world of the region; we find that deep valleys have been excavated and river-courses widened out into arms of the sea, and the whole shape and form of the country changed. No wonder if, with so wide a room for speculation, different observers adopt somewhat different readings of this chapter of unwritten history. I have given you my reading of it, in which I see the antiquity of man carried back so far into the dim past, that even Egyptian chronology, extending as it does over thousands of years, appears but to cover a small link in the long chain of human existence—a chain of which the first link has still to be discovered. If you on your part will attempt to check and verify my reading, and study attentively what is still going on under your eyes, it will bring home to you the mighty effects which may arise from the small but ever-active agents, rains and rivers, tide and time; and whether in the end you agree with my reading or not, you will find that you have added a new interest to your lives.

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